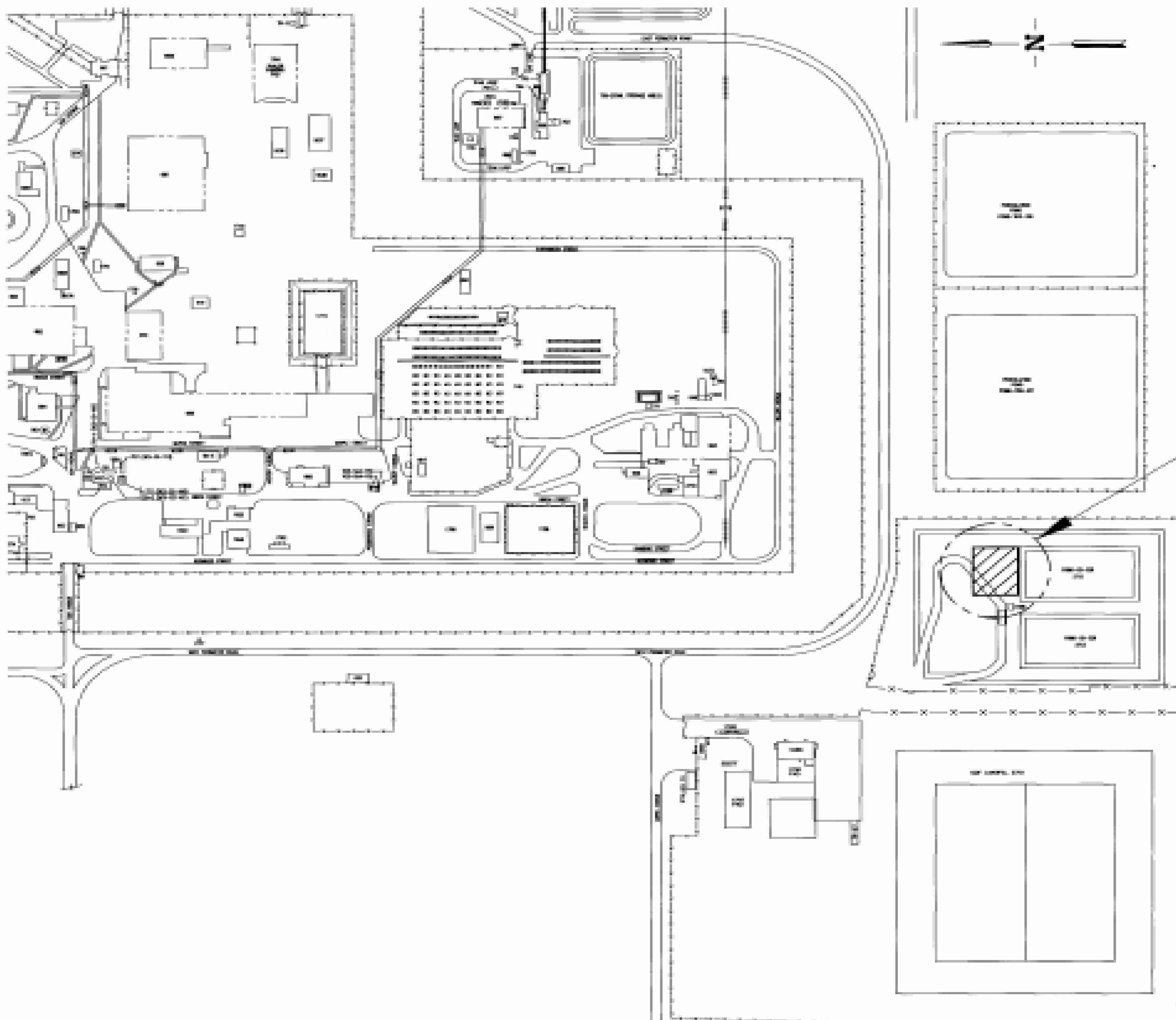
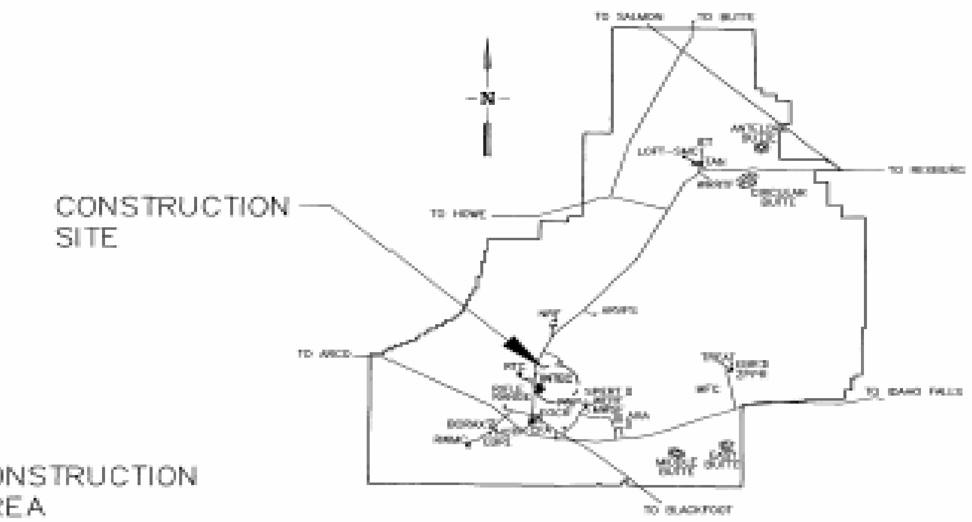
Attachment 1

Design Drawings



INTEC AREA MAP

SCALE: 1"=200.0'



INL SITE MAP

SCALE: NONE

DRAWING INDEX				
PAGE NO.	DWG NO.	SHEET NO.	REV	DRAWING TITLE
1	630873	T-1		SITE MAP, INTEC AREA MAP, AND DRAWING INDEX
2	630874	M-1		EQUIPMENT PLAN
3	630875	P-1		PIPING AND INSTRUMENT DIAGRAM
4	630876	P-2		PIPING AND INSTRUMENT DIAGRAM SHEET 2
5	630877	P-3		PIPING PLAN
6	630878	P-4		SECTION AND DETAILS
7	630879	P-5		SECTIONS AND DETAILS
8	630880	P-6		DETAILS
9	630881	P-7		ENLARGED PLAN AND SECTIONS
10	630882	P-8		PHOTOS
11	630883	HV-1		H & V PLAN, SECTION, AND DETAIL
12	630884	HV-2		H & V SECTIONS AND DETAILS
13	630885	E-1		ONE LINE DIAGRAM AND PANEL SCHEDULE
14	630886	E-2		LIGHTING PLAN, SECTION AND DETAIL
15	630887	E-3		EQUIPMENT PLAN AND ELEVATION
16	630888	E-4		INSTRUMENTATION LAYOUT AND CONDUIT PLAN
17	630889	E-5		SPARGE MOTOR CONTROL PANEL LAYOUT AND DIAGRAMS
18	630890	IN-1		INSTRUMENTATION BLOCK DIAGRAM
19	630891	IN-2		INSTRUMENTATION PANEL LAYOUT
20	630892	IN-3		TSI WIRING DIAGRAM
21	630893	IN-4		LOOP DIAGRAM - SHEET 1
22	630894	IN-5		LOOP DIAGRAM - SHEET 2
23	630895	IN-6		PRESSURE TRANSMITTER CONNECTION DIAGRAM AND DETAIL SH 1
24	630896	IN-7		PRESSURE TRANSMITTER CONNECTION DIAGRAM AND DETAIL SH 2
25	630897	IN-8		TRANSMITTER PANEL LAYOUT

REV | DATE | DESCRIPTION

REVISION HISTORY

SCALE: 1" = 200.0'

DESIGN PHASE: AFC
SAFETY CATEGORY: CG
HORIZONTAL SCALE: NOTED
VERTICAL SCALE: N/A
FOR DRAWING INDEX SEE DRAWING NO. 630873

INITIALS AND DATE FOR CURRENT RELEASE ONLY
DESIGN: KC DECORIA
DRAFTER: K BRONSON
DRAFTING CHECK: SK MACE
TECHNICAL CHECK: EDS
DISC GROUP SUPERVISOR: BR HEYREND
DESIGN PROJECT ENG: DJ HURST

Idaho Cleanup Project

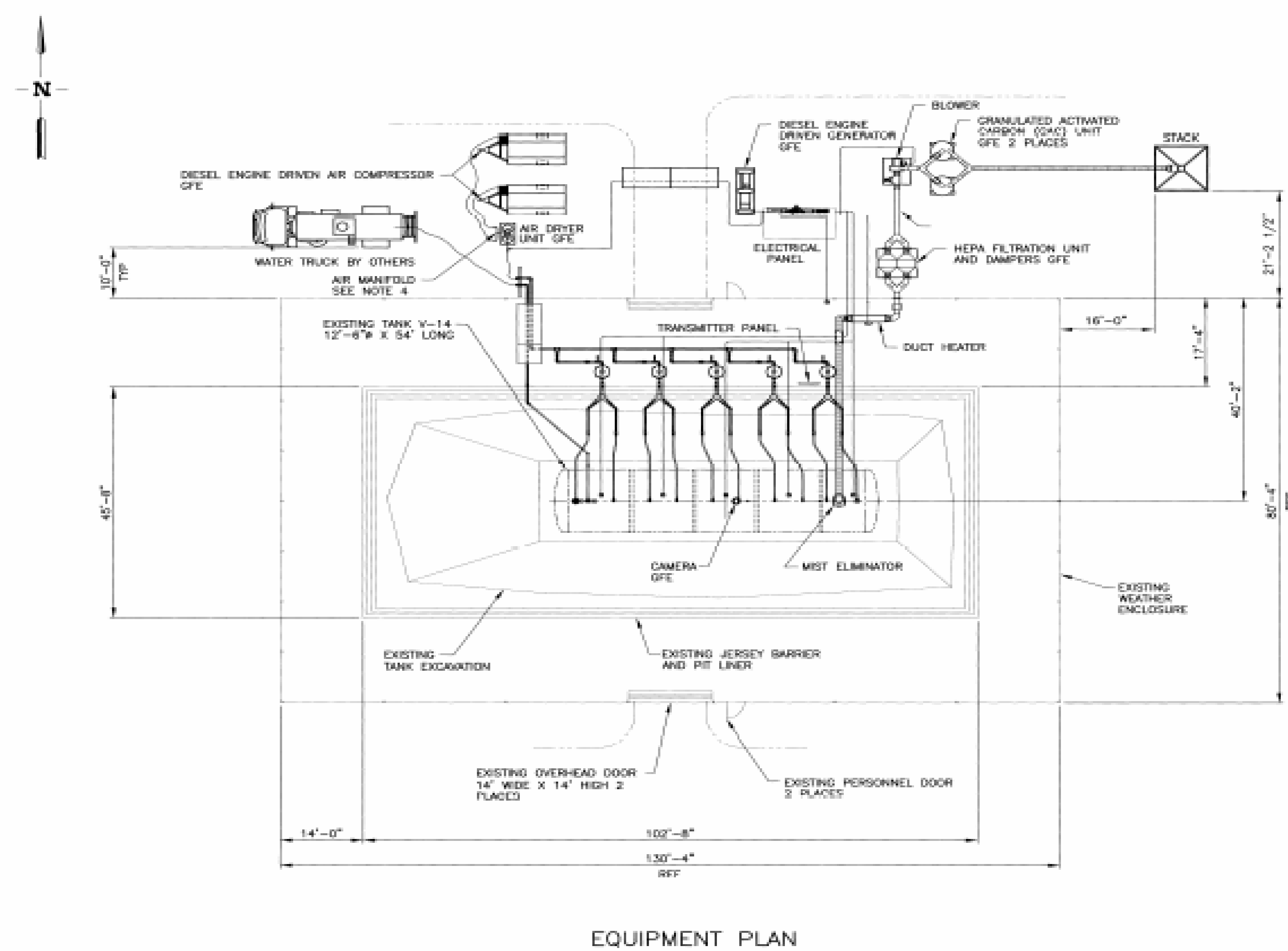
TREATMENT SYSTEM FOR PM-2A
TANK V-14

SITE MAP, INTEC AREA MAP, AND DRAWING INDEX

PROJECT NO. 24872
EFFECTIVE DATE 5/26/05

D DWG 630873

SHEET T-1



EQUIPMENT PLAN

NOTES

1. ALL DIMENSIONS ARE FROM OUTSIDE BUILDING STEEL UNLESS SHOWN OTHERWISE.
2. PROVIDE 4'-0" MIN SEPARATION BETWEEN EQUIPMENT, TYPICAL.
3. MECHANICAL CONTRACTOR SHALL FIELD LOCATE AND INSTALL ALL GFE EQUIPMENT.
4. AIR MANIFOLD TO BE FABRICATED BY SUBCONTRACTOR TO TIE INTO AIR DRYER AND CONNECTION TO MATCH COMPRESSOR SUPPLY CONNECTION.

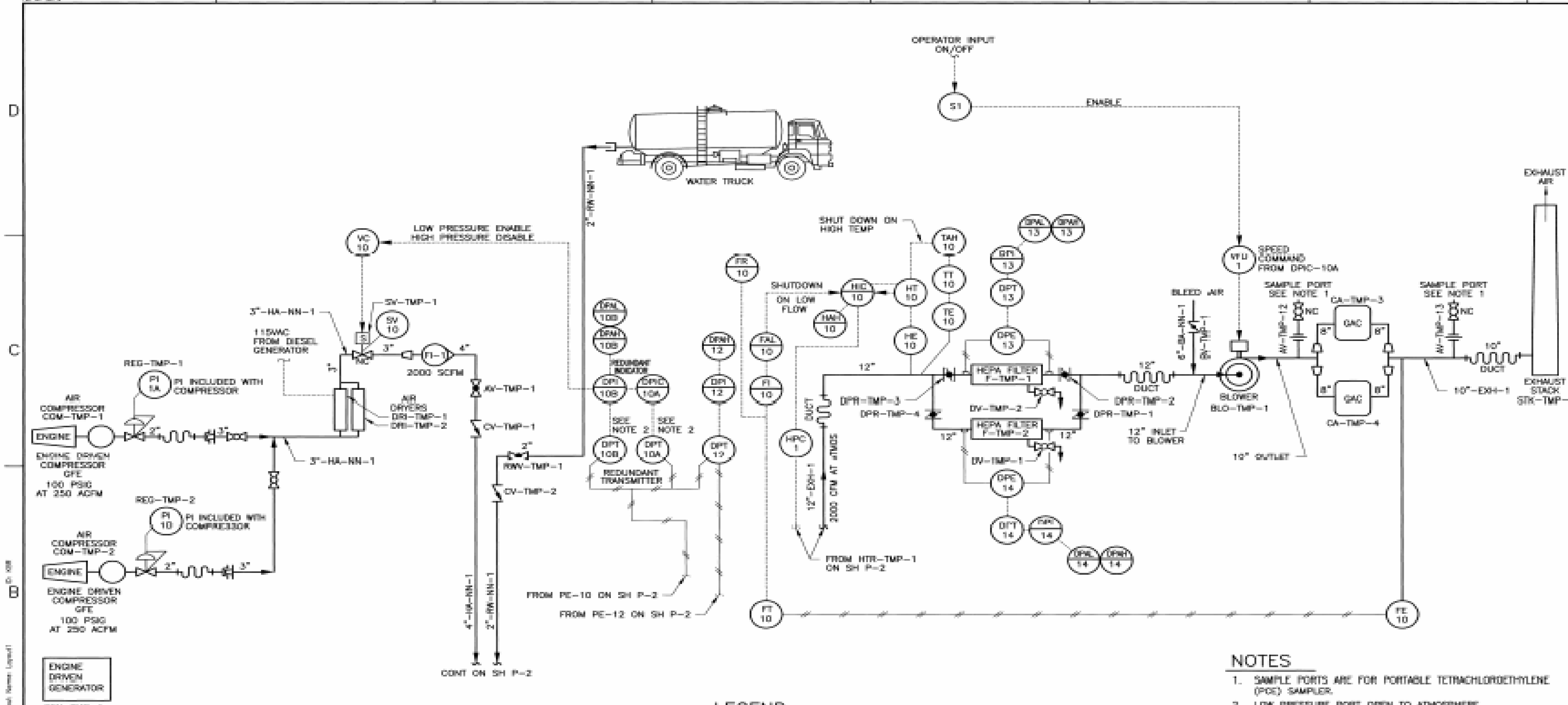
Idaho Cleanup Project

TREATMENT SYSTEM FOR PM-2A TANK V-14

EQUIPMENT PLAN

DESIGN PHASE: AFC
SAFETY CATEGORY: CG
HORIZONTAL SCALE: 3/32"=1'-0"
VERTICAL SCALE: N/A
FOR DRAWING INDEX SEE DRAWING NO. 630873
INITIALS AND DATE FOR CURRENT RELEASE ONLY
DESIGN: KC DECORIA
DRAFTER: K BRONSON
DRAFTING CHECK: DK MACE
ENG GROUP SUPERVISOR: RR HEYREND
DESIGN PROJECT ENG: CJ HURST

PROJECT NO. 24872
EFFECTIVE DATE: 5/26/05
SIZE D DWG 630874
SHEET M-1



NOTES

1. SAMPLE PORTS ARE FOR PORTABLE TETRACHLOROETHYLENE (PCE) SAMPLER.
2. LOW PRESSURE PORT OPEN TO ATMOSPHERE.

LEGEND

AR	AS REQUIRED
AV	AIR VALVE
BA	BLEED AIR
BLO	BLOWER
BV	BLEED AIR VALVE
CA	CARBON ADSORBER
COM	COMPRESSOR
CV	CHECK VALVE
DEM	DEMISTER
DP	DIFFERENTIAL PRESSURE
DPAB	DIFFERENTIAL PRESSURE ALARM BAND
DPAH	DIFFERENTIAL PRESSURE ALARM HIGH
DPAL	DIFFERENTIAL PRESSURE ALARM LOW
DPE	DIFFERENTIAL PRESSURE ELEMENT
DPI	DIFFERENTIAL PRESSURE INDICATOR
DPIC	DIFFERENTIAL PRESSURE INDICATOR CONTROLLER
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
DPR	DAMPER
DRI	DRYER
DV	DRAIN VALVE
EXH	EXHAUST
F	FILTER
FC	FLOW CONTROLLER
FE	FLOW ELEMENT/SENSOR
FI	FLOW INDICATOR
FO	FUEL OIL
FR	FLOW RECORDER
FT	FLOW TRANSMITTER
FV	FUEL OIL VALVE
GAC	GRANULAR ACTIVATED CARBON
GFE	GOVERNMENT FURNISHED EQUIPMENT
HA	HIGH PRESSURE AIR
HAH	HUMIDITY ALARM HIGH
HE	HUMIDITY ELEMENT/SENSOR
HI	HUMIDITY INDICATOR
HIC	HUMIDITY INDICATOR CONTROLLER
HOP	HOPPER
HPC	HEATER POWER CONTROLLER
HT	HUMIDITY TRANSMITTER
HTR	HEATER
JET	JET PUMP
NC	NORMALLY CLOSED
NN	CARBON STEEL
PE	PRESSURE ELEMENT/SENSOR
PI	PRESSURE INDICATOR
PT	PRESSURE TRANSMITTER
REG	REGULATOR
RW	RAW WATER
RWV	RAW WATER VALVE
S	SWITCH
STK	STACK
SV	SOLENOID VALVE
TAH	TEMPERATURE ALARM HIGH
TE	TEMPERATURE ELEMENT/SENSOR
TI	TEMPERATURE INDICATOR
TMP	TEMPORARY
TT	TEMPERATURE TRANSMITTER
VC	VOLTAGE CONTROLLER
VE	VOLTAGE ELEMENT
VFD	VARIABLE FREQUENCY DRIVE

BALL VALVE
BUTTERFLY VALVE
CHECK VALVE
FLEX HOSE OR DUCT
FLEX HOSE
GLOBE VALVE
PRESSURE REGULATOR
QUICK-CONNECT
BULKHEAD UNION
REDUCER
LOCALLY MOUNTED INSTRUMENT
PANEL MOUNTED INSTRUMENT
FLOW METER
SOLENOID OPERATED VALVE
QUICK DISCONNECT
VACUUM BREAKER
COMPOUND GAUGE, 1/2" MNPT, SST, -10" TO 10" WATER COLUMN RANGE.
PLUG
PNEUMATIC SIGNAL

REV | DATE | DESCRIPTION
REVISION HISTORY

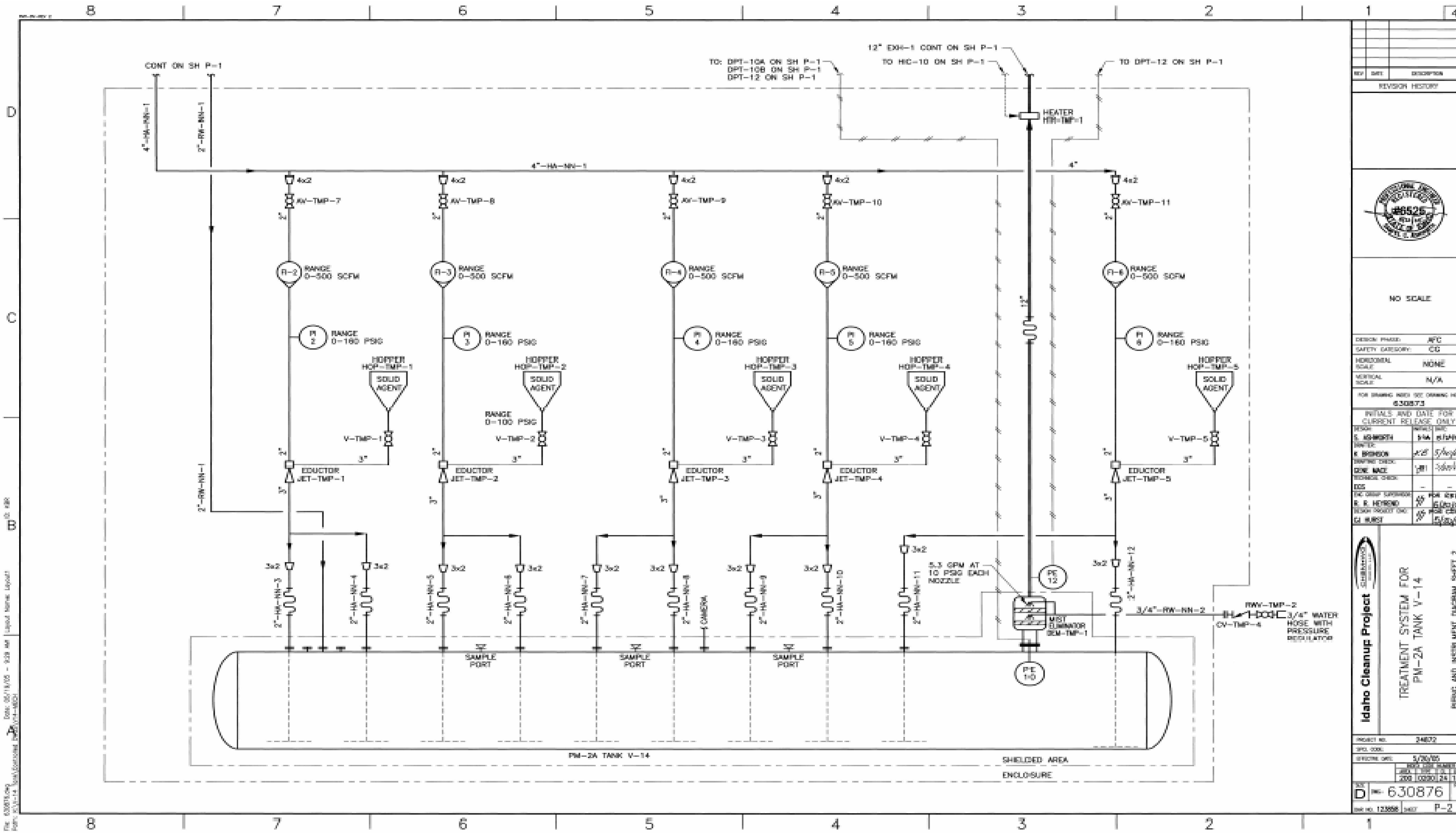
NO SCALE

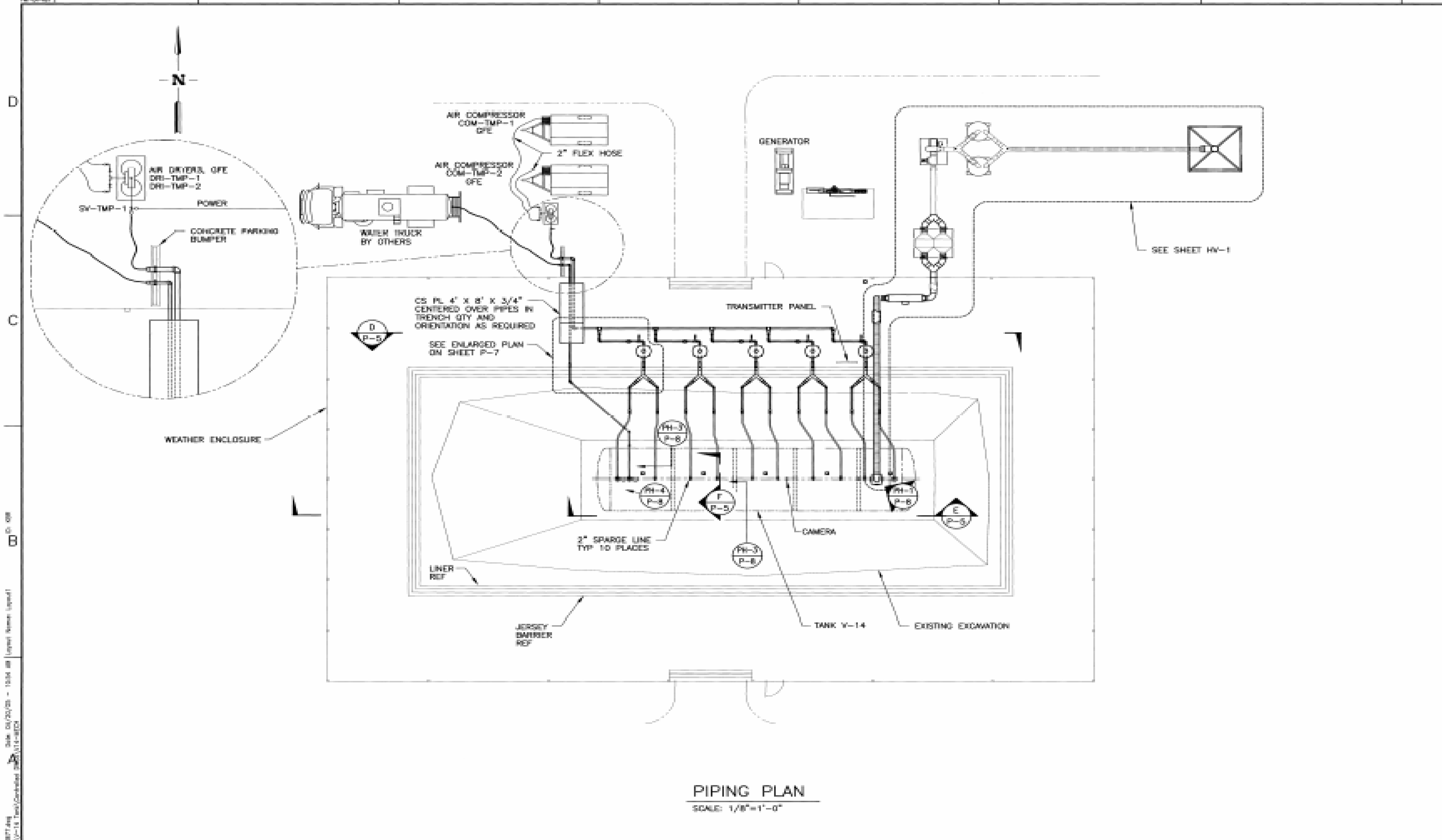
DESIGN PHASE: ATC
SAFETY CATEGORY: CG
HORIZONTAL SCALE: NONE
VERTICAL SCALE: N/A
FOR DRAWING INDEX SEE DRAWING NO. 630873
INITIALS AND DATE FOR CURRENT RELEASE ONLY
DESIGN: S. ASHWORTH
DRAFTER: E. BRONSON
DRAFTING CHECK: U.N. MAIL
TECHNICAL CHECK: EOS
ENG GROUP SUPERVISOR: R. R. HERBERG
DESIGN PROJECT ENG: CJ HURST

Idaho Cleanup Project

TREATMENT SYSTEM FOR PM-2A TANK V-14
PIPING AND INSTRUMENT DIAGRAM

PROJECT NO. 24872
EFFECTIVE DATE 5/20/05
SIZE D DWG 630875
SHEET P-1


CONT ON SH P-1
4"-HA-NN-1
2"-RW-NN-1
TO: DPT-10A ON SH P-1
DPT-10B ON SH P-1
DPT-12 ON SH P-1
12" EXH-1 CONT ON SH P-1
TO HIC-10 ON SH P-1
TO DPT-12 ON SH P-1
HEATER HTR-TMP-1
4x2
AV-TMP-7
AV-TMP-8
AV-TMP-9
AV-TMP-10
AV-TMP-11
RANGE 0-500 SCFM
RANGE 0-160 PSIG
RANGE 0-100 PSIG
HOPPER HOP-TMP-1
HOPPER HOP-TMP-2
HOPPER HOP-TMP-3
HOPPER HOP-TMP-4
HOPPER HOP-TMP-5
SOLID AGENT
V-TMP-1
V-TMP-2
V-TMP-3
V-TMP-4
V-TMP-5
EDUCTOR JET-TMP-1
EDUCTOR JET-TMP-2
EDUCTOR JET-TMP-3
EDUCTOR JET-TMP-4
EDUCTOR JET-TMP-5
3x2
2"-HA-NN-3
2"-HA-NN-4
2"-HA-NN-5
2"-HA-NN-6
2"-HA-NN-7
2"-HA-NN-8
2"-HA-NN-9
2"-HA-NN-10
2"-HA-NN-11
2"-HA-NN-12
CAMERA
SAMPLE PORT
5.3 GPM AT 10 PSIG EACH NOZZLE
PE 12
PE 10
MIST ELIMINATOR DEM-TMP-1
3/4"-RW-NN-2
RWV-TMP-2
CV-TMP-4
3/4" WATER HOSE WITH PRESSURE REGULATOR
PM-2A TANK V-14
SHIELDED AREA
ENCLOSURE
REVISION HISTORY
NO SCALE
DESIGN PHASE: AFC
SAFETY CATEGORY: CG
HORIZONTAL SCALE: NONE
VERTICAL SCALE: N/A
FOR DRAWING INDEX SEE DRAWING NO. 630873
INITIALS AND DATE FOR CURRENT RELEASE ONLY
S. ASHWORTH
K BRONSON
GENE NACE
R. R. HEYREND
GI HURST
Idaho Cleanup Project
TREATMENT SYSTEM FOR PM-2A TANK V-14
PIPING AND INSTRUMENT DIAGRAM SHEET 2
PROJECT NO. 24872
EFFECTIVE DATE 5/20/05
D
630876
P-2



PIPING PLAN

SCALE: 1/8"=1'-0"

REV	DATE	DESCRIPTION

REVISION HISTORY

SCALE: 1/8" = 1'-0"

SCALE: 1 1/2" = 1'-0"

DESIGN PHASE:	AFC
SAFETY CATEGORY:	CG
HORIZONTAL SCALE	NOTED
VERTICAL SCALE	N/A

FOR DRAWING INDEX SEE DRAWING NO. 630873

INITIALS AND DATE FOR CURRENT RELEASE ONLY

	INITIALS	DATE
DESIGN KC DECORIA		
DRAFTER K BRONSON		
DRAFTING CHECK GK MACE		
TECHNICAL CHECK ESS	-	-
GROUP SUPERVISOR RR HEYREND		
DESIGN PROJECT ENG. CJ HURST		

Idaho Cleanup Project

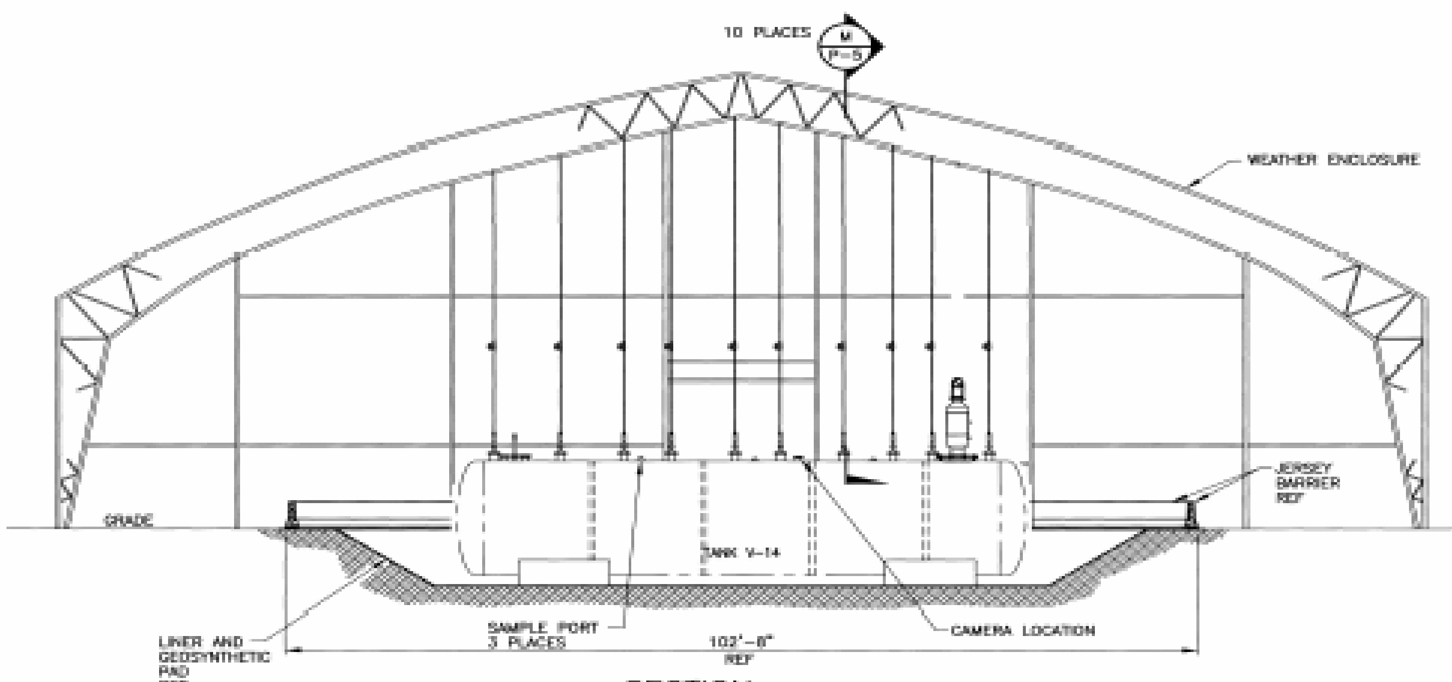
TREATMENT SYSTEM FOR PM-2A
TANK V-14
PIPING PLAN

PROJECT NO.	24872
SPC CODE:	
EFFECTIVE DATE:	5/26/05

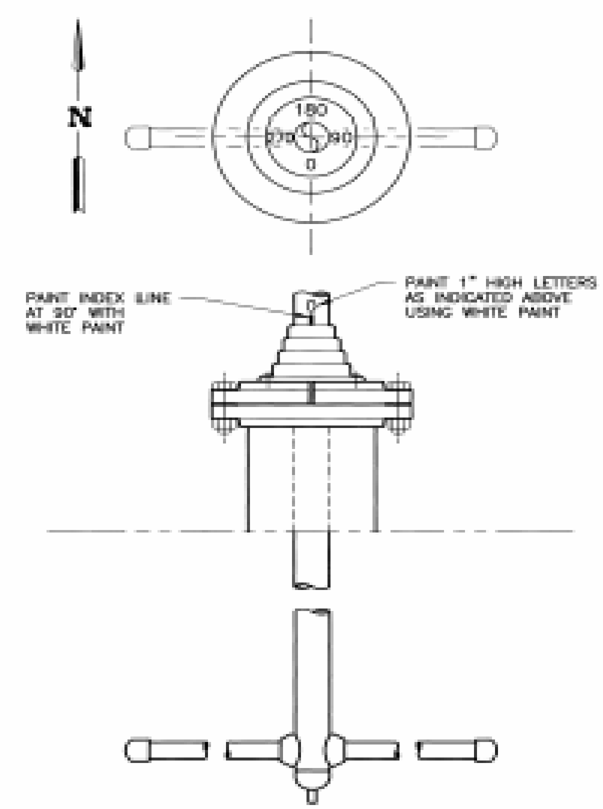
INDEX CODE NUMBER: 590 0200 52 L90

D DWG 630877

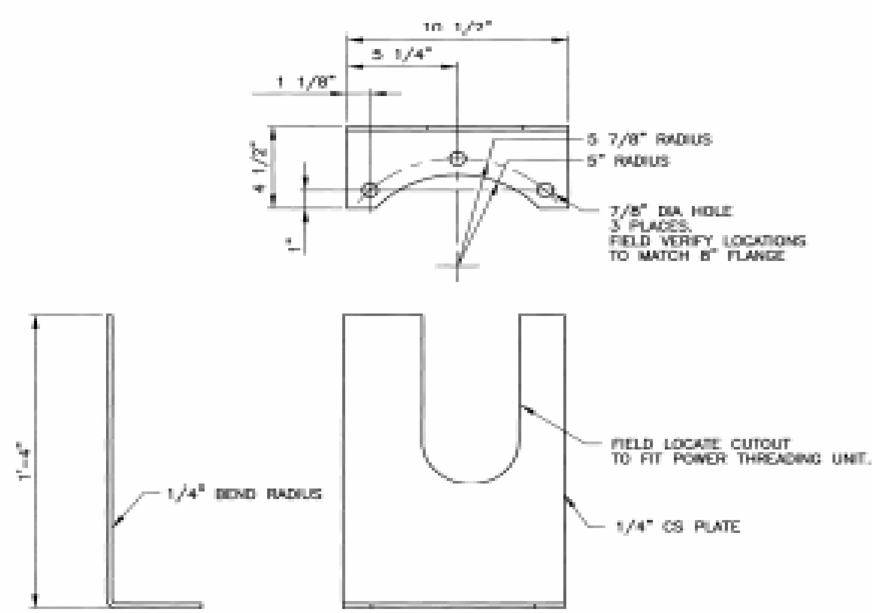
DAR NO. 123658 SHEET P-3



SECTION (B / P-3)
SCALE: 1/8"=1'-0"



DETAIL (16 / P-6)
NTS



DETAIL (17 / P-6)
SCALE: 3"=1'-0"

REV	DATE	DESCRIPTION

REVISION HISTORY

DESIGN PHASE:	AFC
SAFETY CATEGORY:	CG
HORIZONTAL SCALE	1/8"=1'-0"
VERTICAL SCALE	N/A

FOR DRAWING INDEX SEE DRAWING NO. 630873

INITIALS AND DATE FOR CURRENT RELEASE ONLY

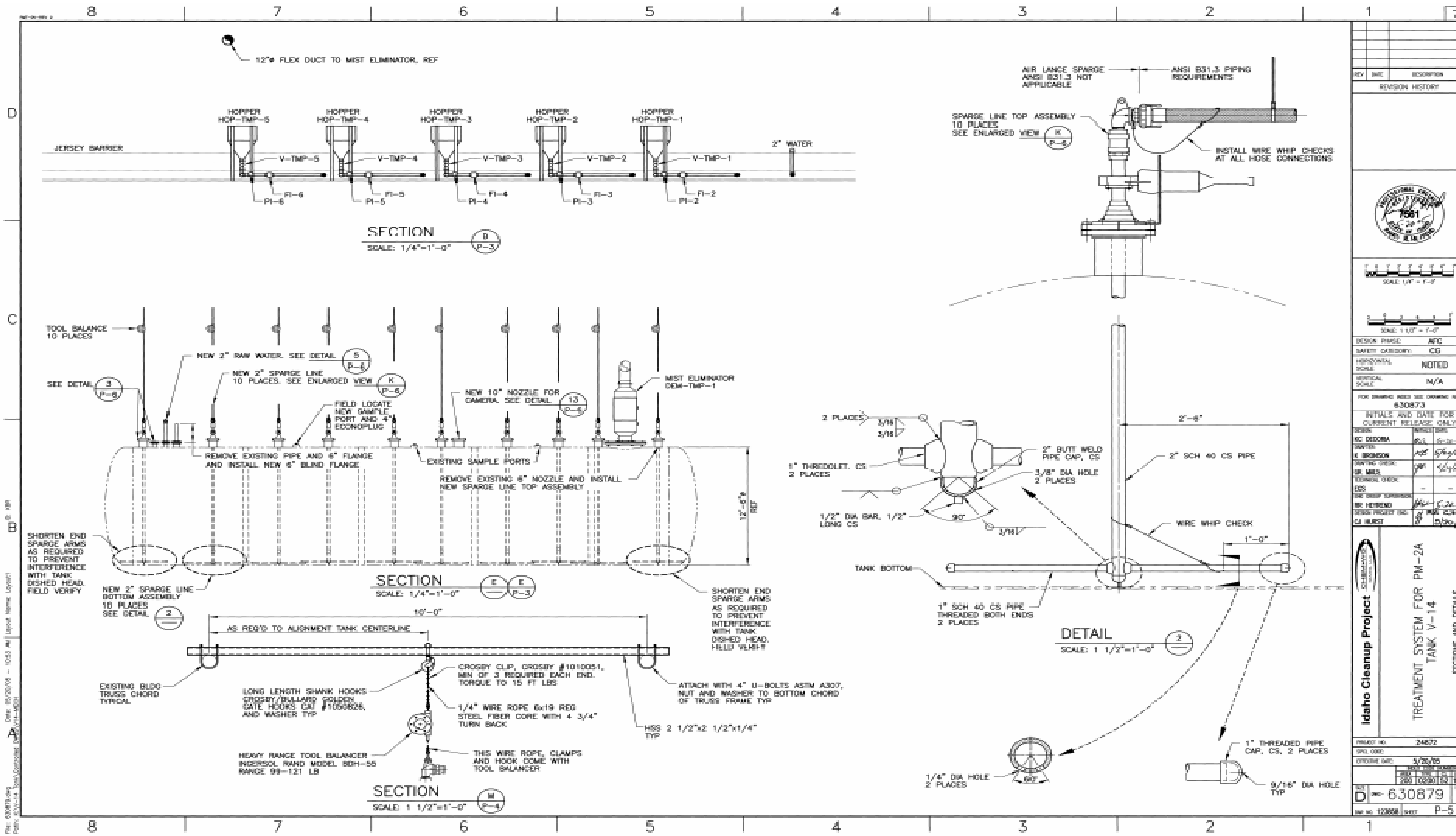
DESIGN: RC DECOMA		
DRAFTER: K BRONSON		
DRAFTING CHECK: GK MACE		
TECHNICAL CHECK: ECS	—	—
ENG GROUP SUPERVISOR: RH HEYRENB		
DESIGN PROJECT ENG: GJ HURST		

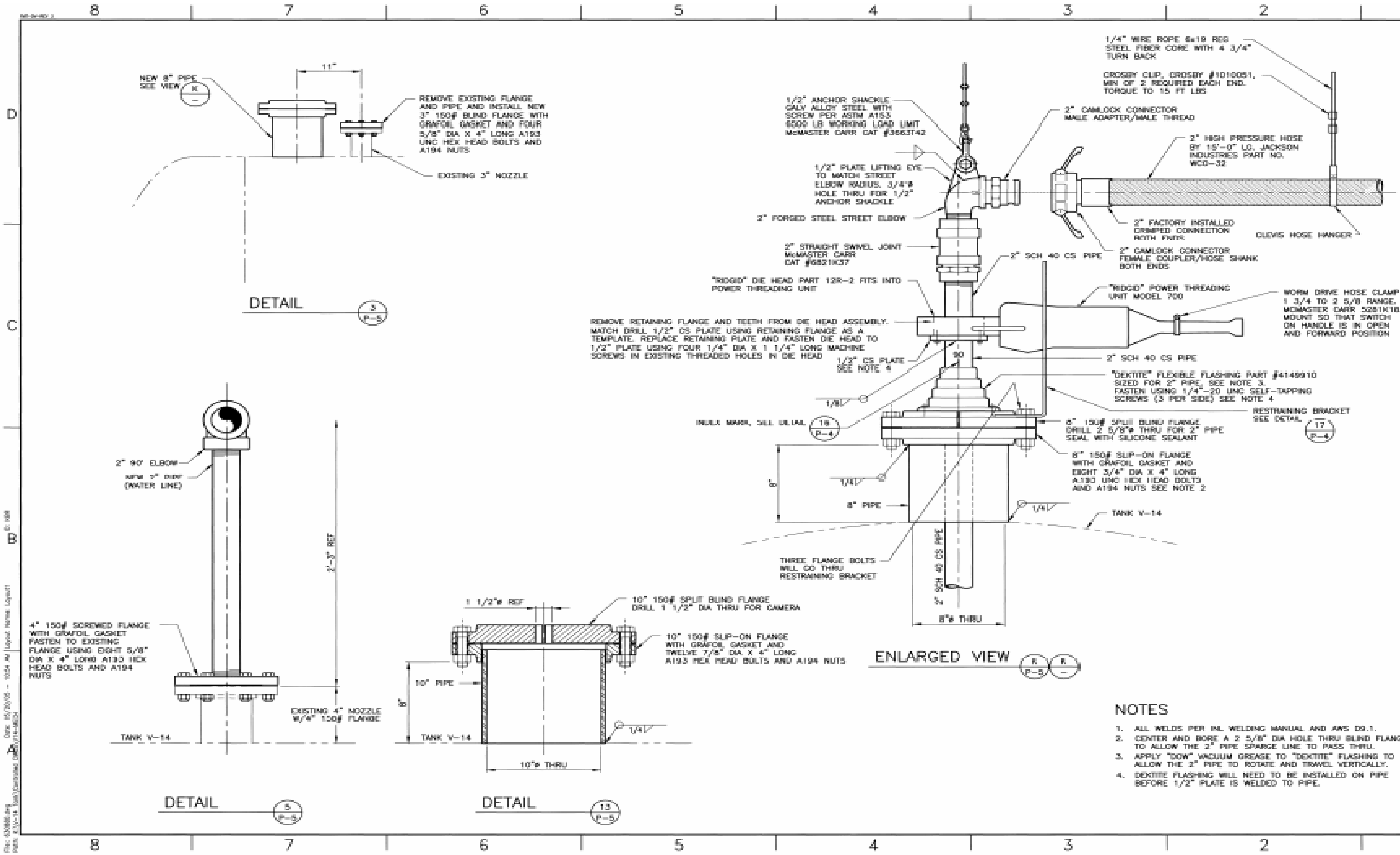
Idaho Cleanup Project

TREATMENT SYSTEM FOR PM-2A
TANK V-14
SECTION AND DETAILS

PROJECT NO.	24872
SPEC. CODE:	
EFFECTIVE DATE:	5/20/05
INDEX CODE NUMBER	200 0200 52 136

SIZE D DWG 630878 REV 6
SHEET P-4


12"ø FLEX DUCT TO MIST ELIMINATOR, REF
JERSEY BARRIER
HOPPER HOP-TMP-5
HOPPER HOP-TMP-4
HOPPER HOP-TMP-3
HOPPER HOP-TMP-2
HOPPER HOP-TMP-1
V-TMP-5
V-TMP-4
V-TMP-3
V-TMP-2
V-TMP-1
2" WATER
FI-6
PI-6
FI-5
PI-5
FI-4
PI-4
FI-3
PI-3
FI-2
PI-2
SECTION D P-3
SCALE: 1/4"=1'-0"
TOOL BALANCE 10 PLACES
NEW 2" RAW WATER. SEE DETAIL 5 P-6
SEE DETAIL 3 P-6
NEW 2" SPARGE LINE 10 PLACES. SEE ENLARGED VIEW K P-6
FIELD LOCATE NEW SAMPLE PORT AND 4" ECONOPLUG
NEW 10" NOZZLE FOR CAMERA. SEE DETAIL 13 P-6
MIST ELIMINATOR DEM-TMP-1
REMOVE EXISTING PIPE AND 6" FLANGE AND INSTALL NEW 6" BLIND FLANGE
EXISTING SAMPLE PORTS
REMOVE EXISTING 6" NOZZLE AND INSTALL NEW SPARGE LINE TOP ASSEMBLY
12'-6"ø REF
SHORTEN END SPARGE ARMS AS REQUIRED TO PREVENT INTERFERENCE WITH TANK DISHED HEAD. FIELD VERIFY
NEW 2" SPARGE LINE BOTTOM ASSEMBLY 10 PLACES SEE DETAIL 2
SECTION E E P-3
SCALE: 1/4"=1'-0"
10'-0"
AS REQ'D TO ALIGNMENT TANK CENTERLINE
EXISTING BLDG TRUSS CHORD TYPICAL
LONG LENGTH SHANK HOOKS CROSBY/BULLARD GOLDEN GATE HOOKS CAT #1050626, AND WASHER TYP
CROSBY CLIP, CROSBY #1010051, MIN OF 3 REQUIRED EACH END. TORQUE TO 15 FT LBS
1/4" WIRE ROPE 6x19 REG STEEL FIBER CORE WITH 4 3/4" TURN BACK
HEAVY RANGE TOOL BALANCER INGERSOL RAND MODEL BDH-55 RANGE 99-121 LB
THIS WIRE ROPE, CLAMPS AND HOOK COME WITH TOOL BALANCER
HSS 2 1/2"x2 1/2"x1/4" TYP
ATTACH WITH 4" U-BOLTS ASTM A307, NUT AND WASHER TO BOTTOM CHORD OF TRUSS FRAME TYP
SECTION M P-4
SCALE: 1 1/2"=1'-0"
AIR LANCE SPARGE ANSI B31.3 NOT APPLICABLE
ANSI B31.3 PIPING REQUIREMENTS
SPARGE LINE TOP ASSEMBLY 10 PLACES SEE ENLARGED VIEW K P-6
INSTALL WIRE WHIP CHECKS AT ALL HOSE CONNECTIONS
2 PLACES
3/16
1" THREDOLET, CS 2 PLACES
1/2" DIA BAR, 1/2" LONG CS
90°
2" BUTT WELD PIPE CAP, CS
3/8" DIA HOLE 2 PLACES
2'-6"
2" SCH 40 CS PIPE
WIRE WHIP CHECK
1'-0"
TANK BOTTOM
1" SCH 40 CS PIPE THREADED BOTH ENDS 2 PLACES
DETAIL 2
SCALE: 1 1/2"=1'-0"
1/4" DIA HOLE 2 PLACES
60°
1" THREADED PIPE CAP, CS, 2 PLACES
9/16" DIA HOLE TYP
REV DATE DESCRIPTION
REVISION HISTORY
7581
SCALE: 1/4" = 1'-0"
SCALE: 1 1/2" = 1'-0"
DESIGN PHASE: AFC
SAFETY CATEGORY: CG
HORIZONTAL SCALE NOTED
VERTICAL SCALE N/A
FOR DRAWING INDEX SEE DRAWING NO. 630873
INITIALS AND DATE FOR CURRENT RELEASE ONLY
KC DECORIA
K BRONSON
SR MILLS
ECS
BR HEYRENO
CJ HURST
Idaho Cleanup Project
TREATMENT SYSTEM FOR PM-2A TANK V-14
SECTIONS AND DETAILS
PROJECT NO. 24872
EFFECTIVE DATE: 5/20/05
D
630879
P-5
120858



NOTES

1. ALL WELDS PER INL WELDING MANUAL AND AWS D9.1.
2. CENTER AND BORE A 2 5/8" DIA HOLE THRU BLIND FLANGE TO ALLOW THE 2" PIPE SPARGE LINE TO PASS THRU.
3. APPLY "DOW" VACUUM GREASE TO "DEKTITE" FLASHING TO ALLOW THE 2" PIPE TO ROTATE AND TRAVEL VERTICALLY.
4. DEKTITE FLASHING WILL NEED TO BE INSTALLED ON PIPE BEFORE 1/2" PLATE IS WELDED TO PIPE.

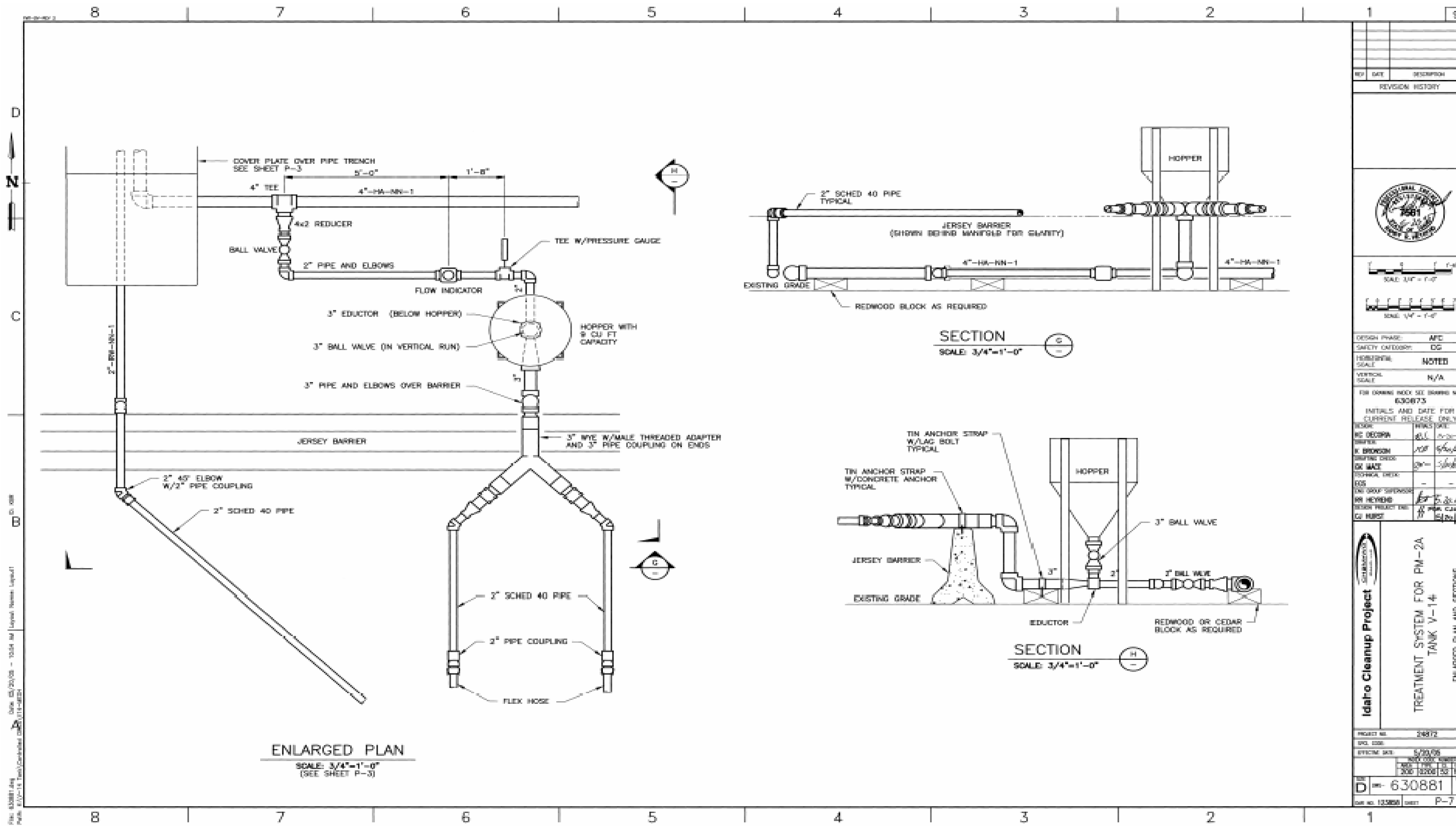
REVISION HISTORY

DESIGN PHASE: AFC
SAFETY CATEGORY: CG
HORIZONTAL SCALE: 3"=1'-0"
VERTICAL SCALE: N/A
FOR DRAWING INDEX SEE DRAWING NO. 630873

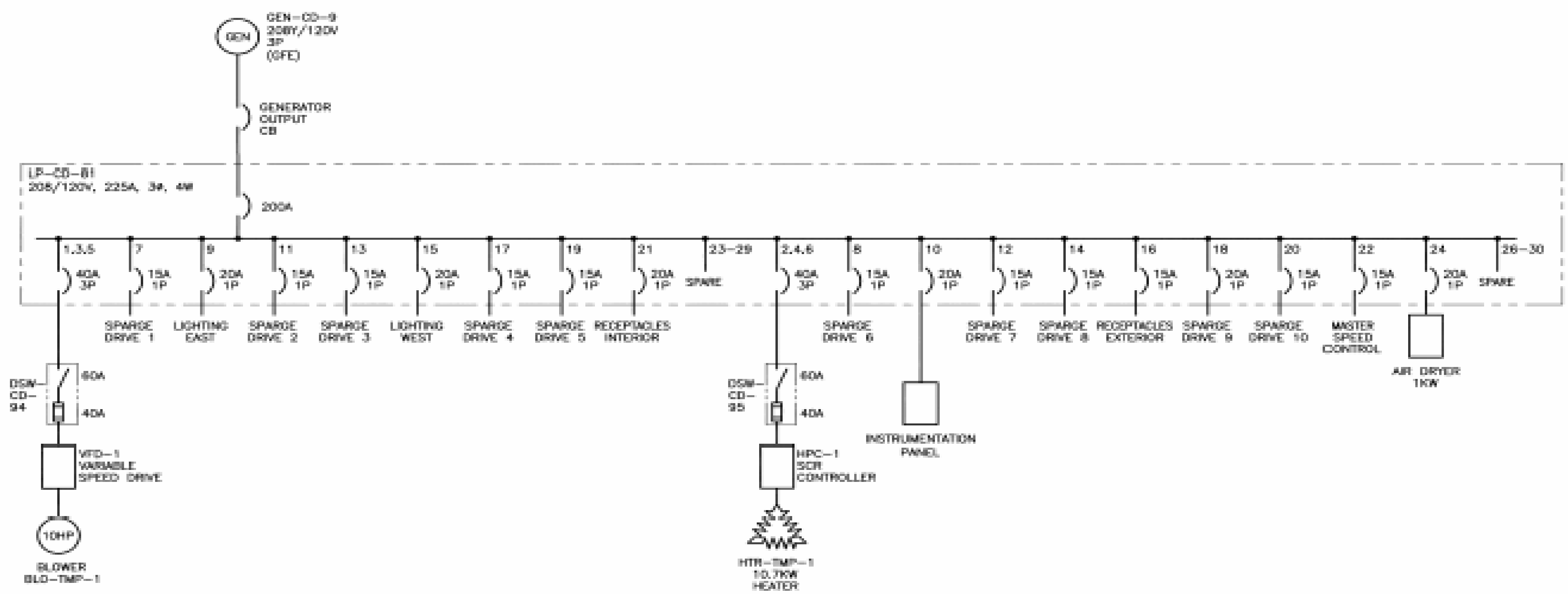
Idaho Cleanup Project

TREATMENT SYSTEM FOR PM-2A
TANK V-14
DETAILS

PROJECT NO. 24872
EFFECTIVE DATE 5/20/05
D DWG. 630880
SHEET P-6



COVER PLATE OVER PIPE TRENCH SEE SHEET P-3
5'-0"
1'-8"
4" TEE
4"-HA-NN-1
4x2 REDUCER
BALL VALVE
2" PIPE AND ELBOWS
TEE W/PRESSURE GAUGE
FLOW INDICATOR
3" EDUCTOR (BELOW HOPPER)
3" BALL VALVE (IN VERTICAL RUN)
HOPPER WITH 9 CU FT CAPACITY
3" PIPE AND ELBOWS OVER BARRIER
JERSEY BARRIER
3" WYE W/MALE THREADED ADAPTER AND 3" PIPE COUPLING ON ENDS
2" 45° ELBOW W/2" PIPE COUPLING
2" SCHED 40 PIPE
2" PIPE COUPLING
FLEX HOSE
ENLARGED PLAN
SCALE: 3/4"=1'-0" (SEE SHEET P-3)
2" SCHED 40 PIPE TYPICAL
JERSEY BARRIER (SHOWN BEHIND MANIFOLD FOR CLARITY)
HOPPER
EXISTING GRADE
REDWOOD BLOCK AS REQUIRED
SECTION
SCALE: 3/4"=1'-0"
TIN ANCHOR STRAP W/LAG BOLT TYPICAL
TIN ANCHOR STRAP W/CONCRETE ANCHOR TYPICAL
3" BALL VALVE
EDUCTOR
REDWOOD OR CEDAR BLOCK AS REQUIRED
SECTION
SCALE: 3/4"=1'-0"
REVISION HISTORY
DESIGN PHASE: AFC
SAFETY CATEGORY: CG
HORIZONTAL SCALE NOTED
VERTICAL SCALE N/A
FOR DRAWING INDEX SEE DRAWING NO. 630873
INITIALS AND DATE FOR CURRENT RELEASE ONLY
RC DECORIA
K BRONSON
GK WAITE
RR HEYRENO
CJ HURST
Idaho Cleanup Project
TREATMENT SYSTEM FOR PM-2A TANK V-14
ENLARGED PLAN AND SECTIONS
PROJECT NO. 24872
EFFECTIVE DATE: 5/20/05
D DWG- 630881
P-7



PANEL LP-CD-81 LOCATION

AMPS 225 MAIN 200A 4 WIRE 3Ø TYPE

VOLTAGE 208/120 FEED BOTTOM MOUNTING SURFACE DIM.

BRANCH CIRCUIT	LINE	LOAD WATTS	AMP TRIP	CKT NO.	A B C	CKT NO.	AMP TRIP	LOAD WATTS	LINE	BRANCH CIRCUIT
BLOWER MOTOR BLO-TMP-1	A	3333	40	1		2	40	3567	A	HEATERS HTR-TMP-1 & HTR-TMP-2
	B	3333		3		4		3567	B	
	C	3333		5		6		3567	C	
SPARGE DRIVE 1	A	800	20	7		8	15	800	A	SPARGE DRIVE 6
LIGHTING EAST	B	1500	20	9		10	20	1000	B	INSTRUMENTATION PANEL
SPARGE DRIVE 2	C	800	15	11		12	15	800	C	SPARGE DRIVE 7
SPARGE DRIVE 3	A	800	15	13		14	15	800	A	SPARGE DRIVE 8
LIGHTING WEST	B	1500	20	15		16	20	360	B	RECEPTACLES EXTERIOR
SPARGE DRIVE 4	C	800	15	17		18	15	800	C	SPARGE DRIVE 9
SPARGE DRIVE 5	A	800	15	19		20	15	800	A	SPARGE DRIVE 10
RECEPTACLES INTERIOR	B	1080	20	21		22	15	100	B	MASTER SPEED CONTROL
SPACE	C			23		24	20	1000	C	AIR DRYER
SPACE	A			25		26			A	SPACE
SPACE	B			27		28			B	SPACE
SPACE	C			29		30			C	SPACE

TOTAL LOAD/PHASE-WATTS A 11700 B 12440 C 11100 FED

AMPS/PHASE A 97.50 B 103.67 C 92.5 FROM GEN-CD-9

WIRE SIZE 4#3/0 & 1#4 EG CONDUIT SIZE 2 1/2" RMC

SHORT CIRCUIT INTERRUPTING CAPACITY 18KA

REV | DATE | DESCRIPTION

REVISION HISTORY

NO SCALE

DESIGN PHASE: AFC

SAFETY CATEGORY: CG

HORIZONTAL SCALE: NONE

VERTICAL SCALE: N/A

FOR DRAWING INDEX SEE DRAWING NO. 630873

INITIALS AND DATE FOR CURRENT RELEASE ONLY

DESIGN: J.E. DUGGAN

DRAFTER: JLC/RLS/DHM

DRAFTING CHECK: C. MAZE

TECHNICAL CHECK: EGS

ENG. GROUP SUPERVISOR: W.H. REED

DESIGN PROJECT ENG.: C.J. HURST

Idaho Cleanup Project

TREATMENT SYSTEM FOR PM-2A TANK V-14

ONE LINE DIAGRAM AND PANEL SCHEDULE

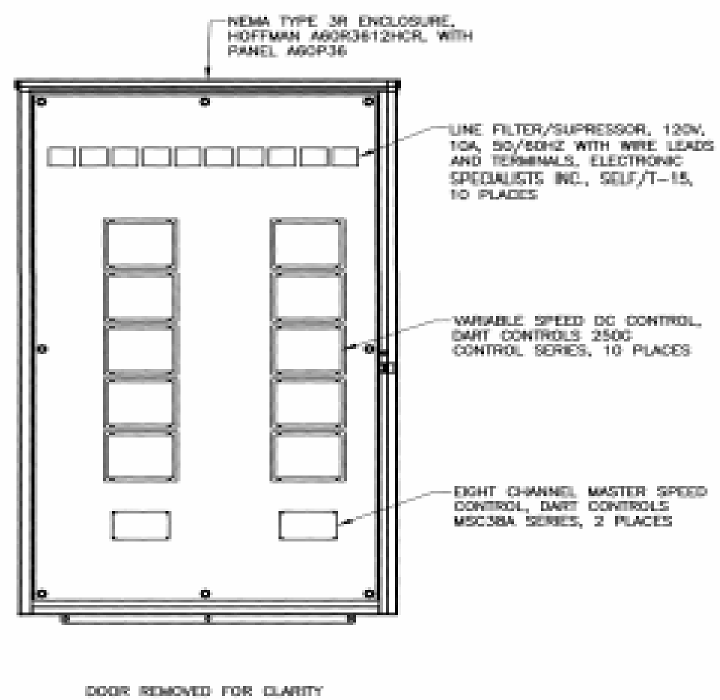
PROJECT NO. 24872

EFFECTIVE DATE: 5/30/05

D DWG- 630885

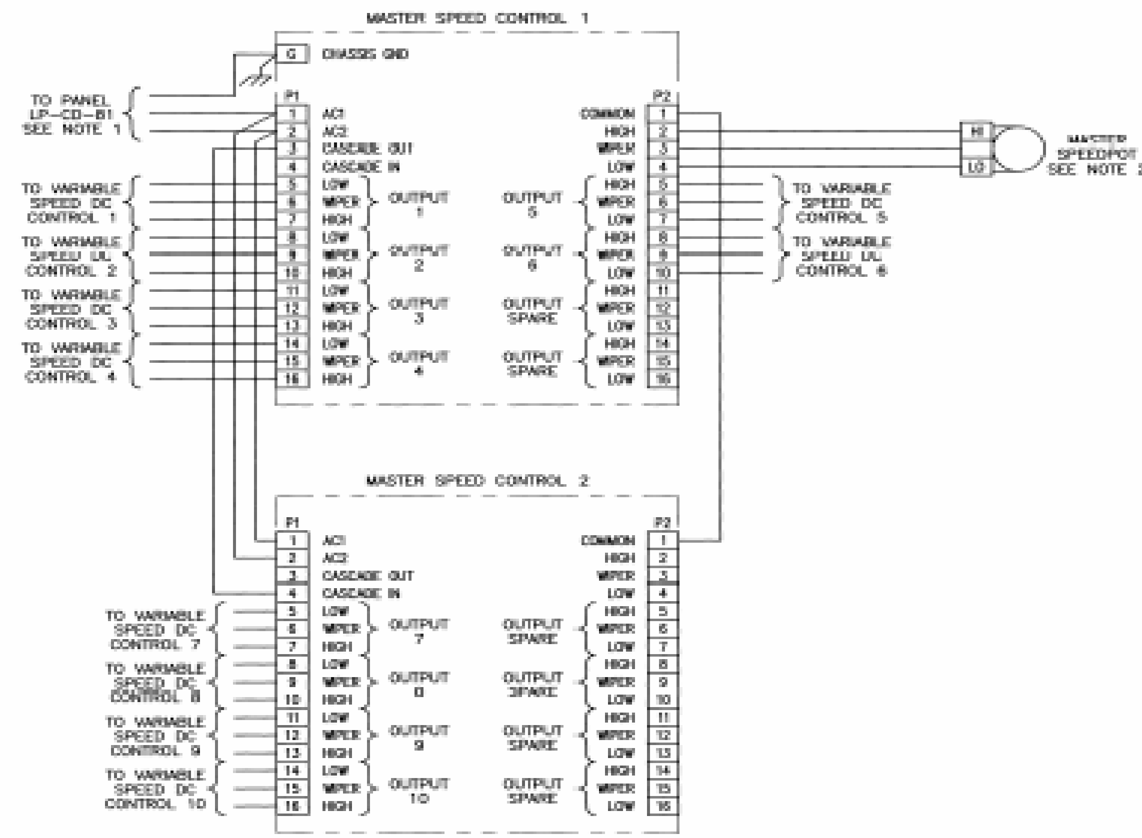
SHEET E-1

13



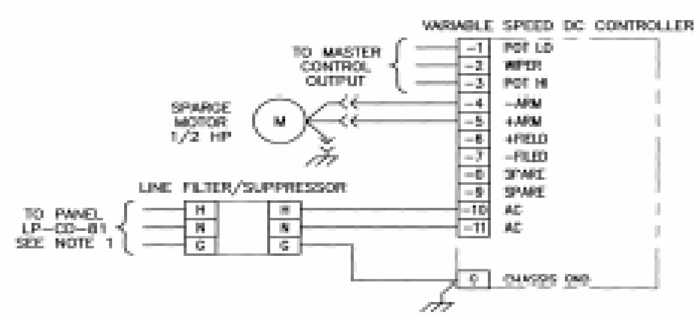
SPARGE MOTOR CONTROL PANEL LAYOUT

SCALE: 1 1/2" = 1'-0"



MASTER CONTROL UNIT DIAGRAM

SCALE: NONE



TYPICAL VARIABLE SPEED DC CONTROLLER DIAGRAM

SCALE: NONE

NOTES

1. SEE DRAWING E-2 FOR ONE LINE AND PANEL SCHEDULE.
2. INSTALL MASTER SPEEDPOT ON THE DOOR OF THE INSTRUMENTATION PANEL.

REVISION HISTORY

REV	DATE	DESCRIPTION

NO SCALE

DESIGN PHASE:	AFC
SAFETY CATEGORY:	CG
HORIZONTAL SCALE:	NONE
VERTICAL SCALE:	N/A

FOR DRAWING INDEX SEE DRAWING NO. 630873

INITIALS AND DATE FOR CURRENT RELEASE ONLY

DESIGN: J.E. DUGGAN
DRAFTER: DH MANWILL
DRAFTING CHECK: V. MACE
TECHNICAL CHECK: SSS
ENG GROUP SUPERVISOR: W.H. REED
DESIGN PROJECT ENG: CJ HURST

Idaho Cleanup Project

TREATMENT SYSTEM FOR PM-2A TANK V-14

SPARGE MOTOR CONTROL PANEL LAYOUT AND DIAGRAMS

PROJECT NO. 24872
EFFECTIVE DATE 5/20/05

DWG 630889 SHEET E-5

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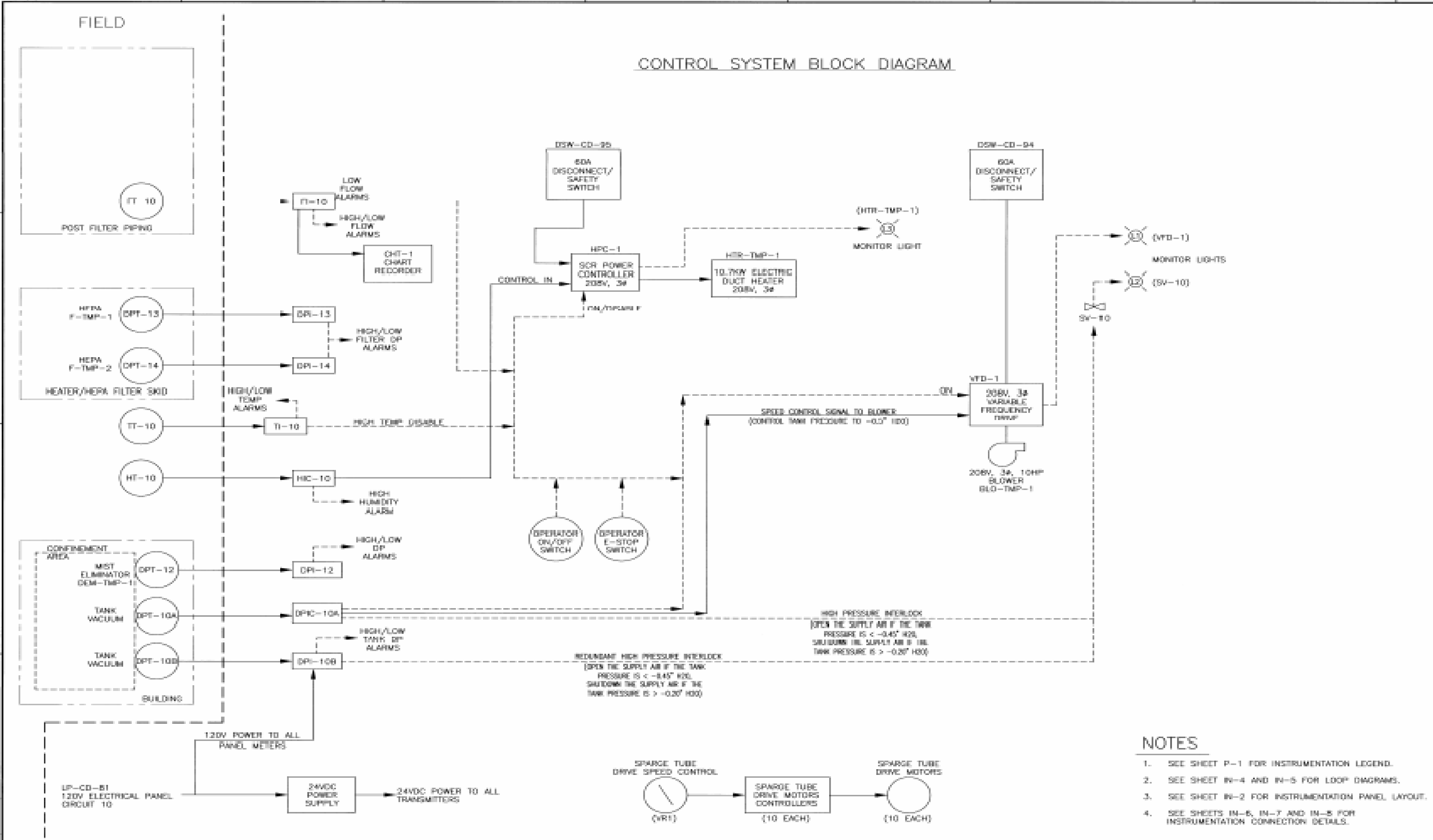
CONTROL SYSTEM BLOCK DIAGRAM



NOTES

1. SEE SHEET P-1 FOR INSTRUMENTATION LEGEND.
2. SEE SHEET IN-4 AND IN-5 FOR LOOP DIAGRAMS.
3. SEE SHEET IN-2 FOR INSTRUMENTATION PANEL LAYOUT.
4. SEE SHEETS IN-6, IN-7 AND IN-8 FOR INSTRUMENTATION CONNECTION DETAILS.

REV | DATE | DESCRIPTION
REVISION HISTORY

NO SCALE

DESIGN PHASE: AFC
SAFETY CATEGORY: CG
HORIZONTAL SCALE: NONE
VERTICAL SCALE: N/A
FOR DRAWING INDEX SEE DRAWING NO. 630873
INITIALS AND DATE FOR CURRENT RELEASE ONLY

Idaho Cleanup Project

TREATMENT SYSTEM FOR PM-2A TANK V-14
INSTRUMENTATION BLOCK DIAGRAM

PROJECT NO. 24872
EFFECTIVE DATE: 5/28/05
D DWG 630890
SHEET IN-1

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Attachment 2

Design Specifications

SECTION 01005--SUMMARY OF WORK

PART 1--GENERAL

SUMMARY:

The Subcontractor shall furnish plant, labor, material, equipment, and supplies (except Government-furnished materials and/or equipment) and perform work and operations necessary to construct the **Treatment System for PM-2A Tank (V-14) at ICDF** complete, in accordance with the subcontract drawings and these specifications.

Section Includes, but is not limited to:

Provide piping and ducting system to allow air and water sparging of an existing 50,000 gallon steel tank

Provide tank exhaust air ventilation system consisting of electric blower with associated ductwork and air filtration system

Provide and install instrumentation system

Install GFE Granulated Activated Carbon Absorber housing

Install GFE HEPA filter housing

Provide sampling ports for VOC sampling

Provide Lighting system within the enclosure

Install and connect GFE electrical generator

Install and connect GFE diesel powered air compressor

Install access opening for camera to be used by others.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	OSHA Occupational Safety and Health Standards
29 CFR 1926	OSHA Health and Safety Standards for Construction

CH2M-WG IDAHO, LLC (CWI)

Subcontractor Requirements Manual

Unless otherwise specified, references in these specifications or on the subcontract drawings to other specifications, codes, standards or manuals that are part of these specifications, but not included herein, shall be the latest edition, including any amendments and revisions, in effect as of the date of this Specification.

SUBMITTALS:

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

QUALITY ASSURANCE:

Quality Assurance Program requirements shall exist to assure that work performed is in conformance with the requirements established by the drawings and this specification. QA Program criteria applicable to this scope of work is addressed in the Special Conditions, CWI Subcontractor Requirements Manual, General Provisions, and these specifications.

Standard Products: The materials and equipment furnished by the Subcontractor shall be standard products of manufacturers regularly engaged in the production of the type of materials and equipment required and shall be of the manufacturer's latest standard designs. Where two or more units of the same type and class of material or equipment are required, the units shall be the product of the same manufacturer, and shall be identical insofar as possible. The component parts of a unit of equipment need not be the products of the manufacturer.

SAFETY, HEALTH AND ENVIRONMENT:

In general work shall be in compliance with the applicable sections of 29 CFR 1910, 29 CFR 1926 and the CWI Subcontractor Requirements Manual.

DELIVERY, STORAGE AND HANDLING:

All materials normally packaged shall be delivered to the site in the original, unopened packages with labels intact. Upon arrival, the Subcontractor shall inspect the materials or equipment for damage.

Materials and equipment shall be stored and handled in accordance with the manufacturer’s instructions. Protect construction materials, equipment, flange facings, threads, machined or painted, and other exposed finished surfaces from damage.

PART 2--PRODUCTS

MATERIALS:

New Materials and Equipment: Materials and equipment received by the Subcontractor in a damaged condition shall be repaired or replaced by the Subcontractor as directed by the Contractor. Materials and equipment damaged by the Subcontractor shall be repaired or replaced by the Subcontractor.

Approved Equal: Whenever a product is specified by using a proprietary name, the name of a manufacturer, or vendor, the specific item mentioned shall be understood as establishing type, function, dimension, and quality desired. Other manufacturer's products may be accepted, provided sufficient information is submitted to determine that products proposed are equivalent to those named.

Hazardous Chemicals and Substances: The Subcontractor shall comply with applicable requirements of 29 CFR 1926.59, Hazard Communication Standard.

PART 3--EXECUTION

CONSTRUCTION AND INSTALLATION:

General: Materials and equipment shall be erected or installed only by qualified personnel who are regularly engaged in the trades required to complete the work. The subcontract drawings show the general arrangement and space allocation of the equipment specified. It shall be the Subcontractor's responsibility to verify changes in conditions or rearrangements necessary because of substitutions for specified materials or equipment. Where rearrangements are necessary the Subcontractor shall, before construction or installation, prepare and submit drawings of the proposed rearrangement for approval.

Coordination of Work: Where new work and existing facilities are shown on the drawings, but are not located precisely by dimensions, the Subcontractor shall be responsible for proper location and clearances and for correcting discrepancies and interferences in the work that are a result of his operations. Work done by one trade that must be integrated with work of other trades shall be laid out with due regard to the work done, or to be done, by other trades; particularly if the work done by one trade depends upon completion or proper installation of work done by other trades. The Subcontractor shall cooperate in coordinating his work with work being done by others if their work must be integrated with the Subcontractor's work. The Subcontractor shall notify the Contractor at least one week prior to starting of the date on which the Subcontractor proposes to proceed with the work.

Workmanship: Work shall be done in a skillful and workmanlike manner. The Subcontractor shall do structural cutting, fitting, patching, repairing and associated work necessary for installation of equipment, piping and electrical conduits, etc. No major cuts or holes, not shown on the drawings, shall be made without prior approval of the Contractor.

After the equipment and/or piping is installed, exposed holes, cracks and other defects shall be neatly patched and the patched areas shall match the adjoining materials and finish.

<u>REPAIR AND RESTORATION</u>:

Materials and equipment repaired or replaced by the Subcontractor shall be subject to acceptance by the Contractor.

<u>PROTECTION</u>:

Construction materials, equipment, flange facings, threads, machined or painted, and other exposed finished surfaces shall be protected from damage during construction.

END OF SECTION 01005

SECTION 15024--PRESSURE PIPING/VESSEL WELDING

PART 1--GENERAL

SUMMARY:

The Subcontractor shall furnish all labor, materials, equipment and services necessary to perform all pressure piping/vessel welding required in accordance with the Subcontract drawings and the following requirements:

Fabrication, testing, inspection, filler materials and workmanship requirements shall conform to the appropriate code

Welds will not be accepted unless the welding has been specified or indicated in the design documents or otherwise approved. Welding shall be as specified in this Section except where additional requirements are indicated or are specified in other sections.

Work includes, but is not limited to:

Welding required for piping

Integral attachments to piping, vessels, and equipment including other pressure boundary welds.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z49.1	Safety in Welding and Cutting

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	Personnel Qualifications and Certification in Nondestructive Testing

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	Symbols for Welding and Nondestructive Testing
AWS A3.0	Welding Terms and Definitions
AWS B2.1	Specification for Welding Procedure and Performance Qualification

AWS QC1	AWS Standard for Qualification and Certification of Welding Inspectors

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3	Chemical Plant and Petroleum Refinery Piping

Boiler and Pressure Vessel Code (BPV)

Section II	Material Specifications
Section V	Nondestructive Examination
Section IX	Welding and Brazing Qualifications

IDAHO NATIONAL LABORATORY (INL)

INL Welding Manual

DEFINITIONS AND SYMBOLS:

Definitions for welding terms shall be in accordance with AWS A3.0 and ASME Section IX as applicable. Weld symbols shall be in accordance with AWS A2.4, unless otherwise indicated.

SUBMITTALS:

Vendor data requirements are summarized on the Vendor Data Schedule.

Submittals include but are not limited to the following:

Welding personnel performance qualification records

Filler metal manufacturer or independent testing lab typical mill test reports (CMTR) of typical chemical properties for all filler metals. The CMTR shall certify that the material has been inspected and tested in accordance with the requirements of the specification and that the results of the chemical analysis meet the requirements of the specification for the AWS material classification

Weld histories, including requirements listed in Special Conditions, such as reports of each inspection, examination and test

Detailed weld repair procedures

Weld repair reports including weld identification, welder identification number, test procedure, reason for rejection, number of repairs required, and documentation that weld is repaired and accepted

Weld map which shall include the following information: weld procedure specification, unique identification number including welder's identification and completion date

Shop drawings shall show all welds. All necessary information such as location, size, weld preparation, etc. shall be shown. The drawings shall differentiate between shop and field welds. Weld procedures, NDE requirements, and filler material to be used shall be indicated

Purge dam control procedure which shall include the prohibition of dissolvable purge dam material for pneumatically flushed piping systems and include methods to assure removal of all purge dams.

QUALITY CONTROL:

Codes and Standards: Comply with requirements of the current revision of the following codes and standards, as specified in this specification:

ASME B31.3.

General: Components with welds will not be accepted unless the welding has been specified or indicated in the design documents or otherwise approved. Welding shall be a specified in this Section except where additional requirements are indicated or are specified in other sections.

Weld Procedure Qualification: All welding shall be performed in accordance with the requirements of an approved welding program and qualified Welding Procedure Specifications (WPS).

Off-Site Procedures: For any welding which is performed, as a part of this subcontract, off of the INL site, the Subcontractor shall establish and qualify all Welding Procedure Specifications in accordance with the requirements of an approved Welding Program and ASME Boiler & Pressure Vessel Code, Sec IX.

Alternately the Subcontractor may use welding procedures from the INL Welding Manual as specified in PART 3 EXECUTION - Welding Processes paragraph for off-site welding if a letter is submitted as vendor data stating that these procedures are being adopted for use in performance of this subcontract.

On-Site Procedures: Any welding which is performed on the INL site shall be performed in accordance with the qualified Welding Procedure Specifications as provided by the Welding Manual and Part 3 EXECUTION of this section.

Welder Qualification:

Off-Site: All welding which is performed off of the INL site shall be performed by welders or operators qualified in accordance with an approved Welding Program and ASME BPV Code, Section IX. Welders or welding operators qualified to INL Welding Manual procedures can be used for off-site welding if the applicable INL weld procedures are identified and submitted as Vendor Data. When using INL Welding Manual procedures for off-site welding, welders shall be qualified at the INL Welder Test Facility.

On-Site: All on-site welding performed under this specification shall be performed by welders or welding operators qualified at the INL Welder Test Facility using the applicable procedures specified from the INL Welding Manual.

Certification: Upon successful completion of the qualification test, the welder shall be provided with a certificate card by the Subcontractor (off-site) or in compliance with the INL Welding Manual (on-site). The certificate shall state the welding process, codes, and procedures under which the welder is qualified and individual who issued the certificate. The welder shall carry the certificate card when performing welding under this contract. The Subcontractor shall have on file documentation, affidavits, and records of testing and test results which qualified the welder for certification. These records shall be certified by the Subcontractor and shall be submitted to the Contractor as vendor data.

Welder's Identification: The Subcontractor shall assign each welder with an identifying number, letter, or symbol which shall be used by the welder to identify all welds made by him.

Renewal of Qualification: Renewal of qualifications for a welder or welding operator working on-site shall be in accordance with the INL Welding Manual. Renewal of qualifications of a welder or welding operator working off-site shall be as required in ASME BPV Code, Section IX.

Non-destructive Examination Procedures: The Subcontractor shall establish detailed inspection procedures, including the applicable acceptance criteria for each non-destructive examination method specified in PART 3 EXECUTION - QUALITY CONTROL AND TESTING and additionally as required to ensure conformance of the work to the contractual requirements.

Subcontractor's Non-destructive Examination Personnel Qualifications: The Subcontractor's non-destructive examination (including visual examination) personnel shall be qualified for the applicable nondestructive testing method in accordance with the requirements of ASNT SNT-TC-1A for Levels I, II, or III as applicable. Qualification as an AWS Certified Weld Inspector is an acceptable alternative for visual examination. The Subcontractor shall have on file documentation, affidavits, and records of testing and test results which qualified the non-destructive examination personnel. These records of education, training and experience to validate qualification shall be submitted as vendor data.

DELIVERY, STORAGE, AND HANDLING:

Filler metal and backing materials shall be stored, handled and controlled in accordance with an approved Filler Metal and Backing Material Handling, Storage and Control Procedure. As a minimum the procedure shall include the Manufacturer's Recommendations and the requirements of Volume 2 of the INL Welding Manual.

SAFETY:

As a minimum, safety precautions during welding shall conform to ANSI Z49.1 as well as any additional requirements specified in the subcontract documents.

PART 2--PRODUCTS

GENERAL:

Welding equipment, electrodes, filler material, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator utilizing qualified welding procedures.

MATERIALS:

Filler Material: All filler material used in fabrication shall comply with the applicable requirements of ASME BPV Code, Section II, Part C or the equivalent AWS filler material specification and shall have an typical certified material test report (CMTR) issued by the original manufacturer, or independent testing laboratory performing material testing for each lot/heat number submitted to the Contractor for approval before use. Filler metal shall be marked with the heat number. Straight lengths of bare filler metal shall be marked on each end and spools of bare filler metal shall be marked on the side of the spool. Unless otherwise specified the filler metal shall be in accordance with the specified WPS.

Gases: Shielding and purge gas(es) shall be in accordance with the applicable weld procedure.

PART 3--EXECUTION

WELDING OPERATIONS:

Both off-site and on-site welding shall be accomplished in accordance with qualified and approved welding procedures using qualified welders and/or welding operators. The use of such procedures will not relieve the Subcontractor of his responsibility for producing weldments conforming to the specified workmanship requirements. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions.

Welding Processes:

On-Site: INL Welding Procedures, as applicable.

Welding Procedures: All welding shall be in accordance with Specifications from the INL Welding Manual.

Joint Preparation and Fit-up: Joint preparation including end preparation and alignment shall conform to the requirements of the applicable ASME code and the INL Weld Manual and to the following minimum requirements. Surfaces within 2 in. of any weld location shall be free of any oil, grease, paint, or other material that would prevent proper welding or produce objectionable fumes while welding. There shall be no free iron on the weld bead or heat-affected area of any stainless steel weld, or on any surface where mechanical cleaning abrasion or other working of the metal surface has occurred. If the joints of carbon steel are prepared by arc or thermal cutting, the surface shall be ground to bright metal by mechanical means before welding. Plasma arc or laser beam cutting of joint preparations is permitted provided the cut surface is machined or ground a minimum of 1/16 in. to bright metal.

Piping prepared for use with socket weld fittings shall have ends ground smooth, square and flat, with no perceptible burrs or irregularities. When performing automatic pipe welding the pipe end preparation shall be made with tooling making the proper 90° end cut and the proper counterbore.

Pipe shall be cut accurately to measurements shown on the drawings and/or to suit field conditions. It is the responsibility of the Subcontractor to field verify dimensions indicated on drawings prior to fabrication. A template shall be used in laying out headers, laterals and other irregular details to ensure accurate cutting and a proper fit-up.

Welding Requirements:

General: Welds shall be designed to provide complete fusion with the base metal. Pressure retaining groove welds shall be complete joint penetration welds unless otherwise specified. Weld beads shall be contoured to provide complete fusion at the sides of the bevel and to prevent slag entrapment. Flux, weld spatter and slag shall be removed from each weld bead prior to depositing the succeeding pass. Arc strikes outside the area of permanent welds shall be avoided on base metal. Welds shall be finished as required for the applicable nondestructive examination method. Accessible welds on the inside surface of vessels prior to final closure shall be ground smooth and free of pits, crevices and sharp projections. Peening shall not be allowed.

Structural Attachments: Permanent structural attachments shall not be welded to pressure retaining parts unless such attachment is specified, indicated or approved by the Design Engineer. Such welds shall be inspected by the liquid penetrant method or magnetic particle method, as specified. Welding shall not be performed after final stress relief and/or hydrostatic testing.

Tack Welds and Temporary Welds: Qualified procedures and welders shall be used to make tack welds and to weld temporary attachments. Tack welds shall be inspected visually for defects and, if found to be defective, shall be removed. Areas from which temporary attachments have been removed shall be dressed smooth and inspected visually for conformance with the minimum thickness requirements of the parent metal, and shall be examined by the liquid penetrant method or magnetic particle method as specified. Welds found to be defective shall be repaired by a qualified welder and re-examined.

Welding Sequence: Welds that are located under nozzle necks, external reinforcement or other obstructions shall be inspected and nondestructively examined prior to attachment of the obstruction. Welded joints connecting new piping or equipment to existing piping or equipment shall be made only after new piping or equipment has been successfully tested and cleaned.

Identification of Welds: The welder shall permanently affix his assigned identification mark and applicable weld identification number adjacent to the weld using a vibro-etch tool. The welder shall also record this information on the weld map.

Weld Repairs:

1. Defects shall be completely removed by grinding or other approved means to clean, sound metal. Excavated areas shall be MT or PT inspected by the Contractor's Representative to assure defect removal.

2. Repairs to correct weld defects shall be made using the same procedure used for the original weld or other previously authorized weld repair procedures.

3. Repaired areas shall be re-examined using the same inspection procedures by which the defect was originally detected and the inspection which was originally specified for the weld.

4. No more than two repair attempts will be allowed on any one weld.

    a. Cutting out and rebeveling then rewelding is considered a weld repair
    b. No further attempts to repair shall be carried out without the written authorization of the Contractor
    c. Weld repairs subsequent to the first two repair attempts shall be made only after receiving written approval of Subcontractor's repair procedures.

5. Arc Strikes: Cracks and blemishes caused by arc strikes shall be ground to a smooth contour but no more than 1/32 in. of the base metal shall be removed. Arc strikes extending more than 1/32 in. into the base metal shall be considered as a weld defect and repaired as specified. Ground arc strikes in

carbon steel shall be subjected to magnetic particle examination and in stainless steel shall be subjected to liquid penetrant examination.

FIELD QUALITY CONTROL:

Inspections, examinations, and tests, for welds and weldments, shall be performed by qualified inspection, examination, and testing personnel in accordance with the approved procedures. All welds are subject to inspection by the Contractor's Representative who reserves the right to accept, reject or demand removal of welds which are in violation of this specification or the applicable welding procedure specification. The Subcontractor shall provide access for this activity.

The Subcontractor shall coordinate the performance of non-destructive examinations with the fabrication and installation of the piping systems, so as to minimize interferences in the performance of both scopes of work and other unrelated work.

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

Weld Testing and Inspections:

Non-Destructive Examination and Visual Weld Inspection: All welds shall receive a visual examination (VT) in accordance with ASME Section V Article 9. VT inspection shall be performed, evaluated and documented by Contractor’s Representative for on-site welds.

Subcontractor are responsible for all off site welds and will submit VDR visual examination (VT) and weld history records in accordance with vendor data schedule for all off-site welds, prior to installation on-site.

END OF SECTION 15024

SECTION 15201--PROCESS PIPING

PART 1--GENERAL

SUMMARY:

Section Includes, but is not limited to:

Furnish (except GFE) and install all valves, tubing, pipe, flanges, traps, fittings, couplings, strainers, hangers, supports, insulation, and appurtenances as required to complete the work as shown on the Subcontract drawings

Fabricate, install, inspect, and test in accordance with the subcontract specifications and drawings and ASME B31.3. Comply with ASME B31.3 Chapters I through VII.

Related Sections: All welding and weld inspection shall be as specified in Section 15024.

Upon completion of the piping systems, the Subcontractor shall test as specified in Section 15600 to verify that the systems are properly installed.

REFERENCES:

The following document including others referenced therein, form part of this Section to the extent designated herein.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3 Process Piping

MATERIAL DELIVERY, STORAGE, AND HANDLING:

The Subcontractor shall ensure that all materials are delivered in a new, undamaged, and protected condition. The finished materials shall be packaged for shipment, pipe ends and tube ends shall be capped with plastic caps to protect the material from dirt and contamination during shipment and subsequent storage.

All materials shall be inspected by the Subcontractor prior to acceptance. If damage is found or any material identification and/or documentation is missing, the Subcontractor shall promptly report the deficiency to the delivering carrier, the manufacturer, and/or the Contractor's representative as appropriate.

Materials shall be resealed and repacked after inspection. The Subcontractor shall ensure that materials are stored in a manner to provide protection against damage, atmospheric corrosion and contamination.

SUBMITTALS:

Flexible Air hose assembly test report: The manufacturer shall provide a hydrotest report certify that each flexible hose has been tested to 150% of the operating pressure stated in this specification.

Also refer to Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

Fabrication, installation, inspection, and testing shall be in accordance with the Subcontract specifications and drawings and ASME B31.3 Category D and Normal as identified in Part 3. Comply with ASME B31.3 Chapters I through VII.

Qualifications: Piping and components shall be furnished and installed by a firm regularly engaged in this type of work, and shall maintain shop and facilities for fabrication and maintenance of subject equipment.

Items of Any One Classification: Items that are used in quantity, such as valves, specialties, accessories, fittings, etc., shall in each case be the product of one manufacturer, and shall be used only for the services recommended by the manufacturer.

Materials, Products and Equipment: Materials, products and equipment shall be furnished and installed in strict accordance with the Subcontract drawings and these specifications.

PART 2--PRODUCTS

MATERIALS:

General: All materials, products and equipment shall be as manufactured by the manufacturer specified in this section, or an approved equal. All materials furnished shall be permanently marked or tagged to show ASTM Designation and type of material. Materials shall not be steel stamped for identification.

Where instruments, valves, equipment or controls are specified, the descriptive narrative shall govern over the catalog part number or model number.

Unless otherwise specified, all pipes shall be sized according to the drawings. All valves, unless otherwise specified, shall be sized for the line into which they will be installed.

LINE CLASS AM STAINLESS STEEL:

Tubing:

1/8" - 1" Seamless Stainless Steel ASTM A269 TP 304, .035" wall.

Piping: Piping shall be Schedule 40 ASTM A312, Grade 304, seamless.

Joints: Joints shall be threaded.

Fittings: Fitting shall be forged type 304 (threaded), 150-pound W.O.G. Conforming to ASTM a182 and ASME B16.3.

Tube Fittings:

1/8" - 1" Stainless Steel, ASTM A276 TP316, Swagelok[R] Compression Fittings.

LINE CLASS NN CARBON STEEL:

SERVICE:

Compressed Air (HA)
Raw water (RW)

Piping: Carbon Steel shall be 2 inch, 3 inch, 4 inch Schedule 40 seamless black carbon steel ASTM-A53, Normal pipe size.

Fittings:

2" & Smaller	150# Class, Malleable Iron, SCRD per ASTM A197, SCRD per ASTM A105.
All Sizes	Seamless wrought Carbon Steel BWE Sch 40 per ASTM A234 Grade WPB.

Flanges:

3" & Larger	150# ANSI B16.5, Slip-on per ASTM A105 and ASTM A181 Class 70.

Wyes [Pipe]: Wyes shall be 3 inch carbon steel schedule 40 Nominal pipe Size NPS, 45 degree angle on branch, threaded male adapters welded on all ends. Part No. 40PWYE3006C W/ male threaded adaptors all ends.

Apryl Derheimer H-P Products INC., TUBULAR PRODUCTS
512 Gorgas St.,
Louisville, OH 44641
Phone 800-860-8823

Gaskets: As specified on the Subcontract drawings and ANSI B16.21.

Flange Bolts: Threaded full length per ASTM A193 Grade B7, Hex Nuts per ASTM A194 Grade 2H. Bolt length and size as specified on the Subcontract drawings

Valves:

Check Valves: Swing Check Valves shall be Class 800, ASTM A105 Carbon Steel Construction, minimum pressure rating no less than 1975 psi @ 100° F, NPT connections, valve shall be a swing check, with integral seat and swing type disc. Valve shall conform to the applicable sections of API 598 API 602 ASME/ANSI B1.20.1 B16.11 B16.34 B31.1 B31.3.

Ball Valves: Ball valves shall be 2-Piece, Full Port, Carbon Steel Ball or Brass. Ball valves shall have adjustable stem packing, reinforced PTFE seats, PTFE stem packing, thrust washer and body seal. Valves shall have a minimum Pressure Rating of 1000 psi (70 bars) WOG (non-shock) and 125psi WSP. Valves must conform to MSS-SP-110.

Solenoid Valves (Two-Way): Valve shall be direct acting, normally closed (NC) solenoid valve for continuous duty service in ambient temperature from 0 F to 120 F for compressed air at maximum pressure of 200 psig. Solenoid valve will control the flow in one direction only, as indicated by arrow case on valve body. The valve must be installed in horizontal pipe with solenoid vertical and on top. The valve body shall be brass with NPT threaded ports. Operation voltage shall be 120 VAC/ 60 Hz. Fluid Service is Compressed Air. Electrical enclosure shall be weather tight for out door use. Max differential pressure 200 psi, Type No. F44A39 60 watts AC, AMP hold 1.2 AMPS inrush 8.8. Valves shall be as manufactured by Magnatrol Valve Corp.

Butterfly Valve: Butterfly valves shall be plastic or carbon steel, wafer type, ANSI Class 150, valve to installed between ANSI B16.5 Class 150 lb standard flanges or with NPT connections. Valve shall be equipped with a ratch handle to lock handle in position. Flow direction for the valve shall be from the seat to shaft side. Valve design shall conform to ANSI B16.24. Plastic valve shall be the manufacture' standard materials.

Pressure Regulator: Fisher Pressure Regulator 95H Series 2-inch (DN 50) body size NPT end connection. Maximum Inlet Pressure 600 psig (41,4 bar), Outlet Pressure Ranges 5 to 400 psig.

Flexible Air Hose: Air hose shall be 2 inch ID X 15 ft in length, WCO series constructed of extruded seamless vacuum-formed white tube of open pitch convoluted PTFE Teflon®, with a flexible wire braid of Stainless steel covering the outside of the hose, Hose end connections shall be installed by manufacturer of the hose assembly. Hose fittings and fitting connection methods shall be pressure rated to at least the hose pressure rating. Maximum working hose pressure 500 psi. Hose assemblies shall have a minimum burst pressure rating for a 4:1 safety factor (Burst pressure: working pressure).

The hose connections on each end of the hose will be a metal crimped/swaged Female end camlock connection and shall be hydro tested by the manufacturer to 300 psig.

Pipe Valve Fitting Company
P.O. Box 65765
Salt Lake City, Utah 84165
Ph (801) 487-1039

Whip Checks: Shall be hose to hose made of steel cable. Maximum working pressure is 200 psi. Hose-to-hose whip checks shall have two spring-loaded loop ends.

Flow Meters:

FI-1: Fox FT2 flow meter for 3 inch Diameter pipe rated for greater than 1200 SCFM Compressed Air flow, insertion model Installed per manufacture installation instruction, with 30 pipe diameters of straight run pipe before the flow meter and 10 pipe diameters of straight pipe after the flow meter.

Flow Meter Model Number
FT2-04I-SS-ST-E1-DD-BO-G2

Fox Thermal Instruments, Inc.
399 Reservation Road
Marina, CA 93933
Phone: (831) 384-4300
Fax: (831) 384-4312
E-mail: sales@foxthermalinstruments.com

FI- 2 thru FI-6: CDI-5200

Flow rate scale 3-500 SCFM, 2” Carbon Steel Pipe
200 psig Maximum
Install per manufacture instruction with 30 pipe diameters of straight run pipe before the flow meter and 10 pipe diameters of straight pipe after the flow meter.

Drill Guide: The drill guide facilitates accurately locating the holes that are needed to mount the flow meter. Furnish with a 3/16” drill bit and 3/16” and 1/4” hex wrenches. (5/16” hex wrenches are required for the 3” and 4" meters, and are furnished with those meters.

CDI Meters, Inc.
64 Trapelo Road
Belmont, MA 02478
617 489-2462 or
Toll-free 866 885-2462
617 489-1518

SPECIALTIES:

Power Drive Threading Unit (Sparge Rotational Drive): Shall be a RIDGID Model 700 Power Drive:

- Motor: Universal, 1/2 HP, 115V or 230V 25-60 Hz
- Switch: Double-throw reversible
- Gear Head: All-spur gear reduction. Spring loaded adapter pawl. Hardened steel spindle gear
- Body: Cast aluminum
- Spindle Speed: 32 RPM (no load)
- Capacity: 1/8" - 2" Pipe (30 mm - 50 mm) 1/4" - 1" (6 mm - 25 mm) Bolt (using 00-RB)
- CSA approved
- • Approved to UL Standards (NRTLC)

RIDGID Die Head No. 12 R 2 inch.

Ridge Tool Company
Technical Service Department
400 Clark Street
Elyria, Ohio 44035-6001
Tel: (800) 519-3456
E-mail: TechServices@ridgid.com

Heavy Range Tool Balance: Tool balance shall be Ingersol Rand BHD -55, Range 99-121 pounds.

Dektite EZi-Seal: Flexible pipe flashing with pre-applied sealing gasket, Made of long life flexible weatherproof EDPM rubber, temperature range -45° F to + 250° F. Part Number 4149910, fits pipe outside diameter 2” to 2 ¾” base dimensions 7” X 7”

ITW Buildex
1349 West Bryn Mawr Ave.,
Itasca, Illinois 60143
Telephone 1.800.BUILDEX

Swivel Joint: 2” Straight Ductile iron 600 psi rating, swivel joints rotate 360 degrees on two rows of ball bearings for intermittent rotation. Joints have NPT female threads on both ends. Buna-N O-rings for leak-free, dustproof handling, Vacuum rating is 20” Hg. Max temperature is 225° F.

McMaster-Carr part number 53775K16

Pneumatic Eductor: 3 inch Fig 217 Pneumatic Eductor with style 60 nozzle, Ductile Iron.

Eductor body is designed for 100 psig @ 450 degrees F

Manufacturer Schutte & Koerting
Supplier R. L. Battisti Sales, INC.
1705 Monte Carlo Drive
Salt Lake City, Utah 84121
Tel. (801) 277-8070 Rudy Battisti

Hoppers: 9 Cubic feet, cone bottom tanks, 32" D X 70" overall height, vertical hopper tanks with 60 degree cone bottoms mounted on Three steel legs that provide 27" of ground clearance. The hopper tank is constructed of 12 gauge carbon steel. Included with the tank are (1) 3" FNPT drain, and 1 channel support ring around the open top. The hopper tank is to be painted with red oxide primer only.

Supplier R. L. Battisti Sales, INC.
1705 Monte Carlo Drive
Salt Lake City, Utah 84121
Tel. (801) 277-8070 Rudy Battisti

Pressure Gages: Pressure gages shall conform to the following (Except PI-15, per drawing P-6):

Type: Bottom Entry
Case: ABS polymer
Window: Kostil polymer
Connection: 1⁄4" NPT
Accuracy: ASME Type "B"
Sensing Element: Copper Alloy Bourdon Tube
Welding: Tin Alloy
Working Temperature: -4° F to 176° F (-20° C to 80° C)
SCALE: Per drawings

Water line pressure Regulator: Regulator shall be a Watts Model 263A, Regulator with a 2" diameter, 10-125 psi gauge. Regulator unit shall be adjustable type (2.5 to 5 gpm).
Water Hose: Standard 3/4 inch heavy duty rubber water hose with brass hose threaded NPT connections.

PART 3--EXECUTION

GENERAL INSTALLATION OF ALL SYSTEMS:

Shall be in conformity with the applicable requirements of ASME Code B31.3.

Compressed air - Category D
Water - Category D

The Subcontractor shall field verify all piping dimensions prior to fabrication.

Accessibility: Items such as valves, controls, access doors, specialties, and accessories shall be installed so as to be readily accessible for operation, servicing, maintaining and repairing.

Pipelines: Pipelines shall be installed per the drawings. The Subcontractor shall coordinate the work of all trades involved on this project to prevent interferences. Piping shall not be routed so as to block equipment access panels or to prevent routine maintenance activities. Piping shall be routed around all electrical components to maintain proper National Electrical Code clearances. The Subcontractor shall notify the Contractor of potential interference issues prior to routing piping. Piping or piping insulation with an exterior surface temperature in excess of 30^{o} C shall not be routed within 6 in. of electrical raceways.

Pipes shall be full lengths to greatest extent possible. Piping shall be cleaned of dirt, rust, scale, grease and other foreign matter. Piping shall be kept clean as work progresses. Seal in accordance with UL requirements wherever piping passes through fire walls.

Exposed piping shall be run close to other piping, walls and columns. Runs shall be as close together as possible where under ceilings, slabs, and decks. Rack piping on trapeze hangers where possible.

Indicating instruments shall be installed for easy reading from operating floors or platforms. If 6 ft or more above floors or platforms, set at 45° angle.

Pipe and Tube Bends: A minimum bend radius of five (5) pipe diameters shall be used unless otherwise specified. All bends shall be free from wrinkles, kinks, and thin or flat spots. "Out of Roundness" shall not exceed 8% for internal pressure and 3% for external pressure between the minimum and maximum cross-sectional dimensions. All bends are to be completed prior to beveling, flanging or cutting to length.

PIPE JOINTS AND CONNECTIONS:

Flanged Pipe Joints: Flanged pipe joints shall be in accordance with ASME B31.3. Torque values for flange bolts shall be in accordance with the gasket manufacturers written recommendations for the size and service conditions and ASME Section VIII Division 1 App. 2.

Welded Pipe Joints: Welded joints shall be made in accordance with Welding Section 15024 of these specifications.

Plastic Pipe Joints: Plastic pipe joints shall be made in strict accordance with written instructions of plastic pipe and fitting manufacturer. The recommended materials and installation equipment shall be used to make the joints.

Any leaks, revealed by the pressure testing procedure, shall be repaired at no additional cost to the Operating Contractor. Leaks in PVC piping shall be cut out and piping replaced.

Tube Joints: Tube joints shall be in accordance with ASME B31.3 and the fitting manufacturers written instructions.

PIPE IDENTIFICATION AND VALVE TAGS:

After installation, all pipelines shall be identified by tagging with their line number or designation as shown on the drawings. The tag shall be fabricated from 24 gage, 3/4 in. wide, 3 in. long, AISI Type 303 or 304 stainless steel metal strip with 3/16 in. high letters stamped in the metal surface. Tagging shall be done at 20-ft intervals and at least once in each cell. Any pipes entering or leaving a cell shall be tagged at the sleeve connections on both sides of the penetrations. The tags shall be tied to the line with AISI Type 304 annealed stainless steel bead chain with stainless steel catches. All tags must be free from sharp edges.

Color Coding: All pipelines shall be color coded and identified using full English text names according to the following list:

PIPE CONTENT IDENTIFICATION LIST

PIPE CONTENT AND LABEL TEXT	COLOR*
HIGH PRESSURE AIR	Blue/White
WATER	Green/White
OIL, FUEL	Yellow/Black

* Background Color/Letter Color

Lettering shall be as specified below:

Size of Labels

Outside Diameter of Pipe or Covering (in.)	Width of Color Band	Size of Legend Letters
3/4 to 1 1/4	8	1/2
1 1/2 to 2	8	3/4
2 1/2 to 6	12	1 1/4
8 to 10	24	2 1/2
Over 10	32	3 1/2

(All dimensions are given in inches.)

EQUIPMENT, FIXTURES, ETC.:

Equipment shall be set in place, aligned, connected per the applicable drawing, and made ready for operation. Connections and required safety devices shall be installed. Initial lubrication shall be provided. Controls shall be set for efficient, stable operation.

Fixtures shall be installed and supported per the applicable drawings in a safe, rigid, neat, and orderly manner. They shall be free from undue stresses and made suitable for normal use. Wall mounted supports shall be of the type as recommended by the manufacturer of the fixture used.

All of the above shall be protected from damage during and after installation. At completion, work shall be free from tool marks, discolorations, cracks, scratches, chips and other defects.

<u>HANGERS, SUPPORTS AND FASTENERS</u>:

Pipe hangers shall be fabricated and installed as shown on the Subcontract drawings. Where interferences occur with hanger placement, the Subcontractor shall submit an alternative position to the Contractor for approval.

Hangers shall be capable of supporting the pipe in all loading conditions. They shall allow for free expansion and contraction of the piping, and prevent stress resulting from transferred weight being induced into the pipe or connected equipment. The installation shall support the piping without sagging and shall be clear of the work of other trades.

Supports shall include wall brackets, riser clamps, pipe stands, rollers, insulation protection saddles, pipe saddles, steel sections, and other suitable devices that may be required for the proper installation of piping. Where hangers/supports are not indicated the Subcontractor shall support piping per the following table. Where concentrated loads are from valves or other equipment are in countered the subcontractor shall provide additional pipe supports.

Hanger Spacing and Rod Diameter Table

Single Pipe Size (in.)	Maximum Spacing (ft)	Minimum Rod diameter (in.)
1/4	3	3/8
1/2	5	3/8
3/4	6	3/8
1	7	3/8
1-1/4	8	3/8
1-1/2	9	3/8
2	10	3/8
3	12	1/2
4	14	5/8

<u>INSTALLATION OF INDIVIDUAL SYSTEMS</u>:

The installation of each system shall comply with the rules contained in the "GENERAL INSTALLATION OF ALL SYSTEMS" section. All welding and welding inspection shall be in accordance with Welding Section 15024 of this specification.

FIELD QUALITY CONTROL:

Testing: See Testing Section 15600-1.

Contractor Inspections: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

CLEANING AND PURGING:

Precautions shall be taken to maintain cleanliness of materials and equipment during delivery, storage and installation. Piping, valves, fittings, and equipment shall be visually free from grease, cutting oils, loose particles, ships, or other foreign matter.

All piping systems shall be flushed or purged as follows:

Air lines shall be purged with air at system pressure

Water lines shall be flushed with water at system pressure. Water source shall be as directed by the Contractor’s Representative.

END OF SECTION 15201

SECTION 15600--TESTING PROCESS PIPING

PART 1--GENERAL

SUMMARY:

Section Includes: Work includes, but is not limited to:

Pressure testing all new process piping.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein. Unless otherwise indicated use the latest edition in effect as of the date of these specifications.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME/ANSI B31.3 Chemical Plant and Petroleum Refinery Piping

SUBMITTALS:

See the Vendor Data Schedule.

PART 2--PRODUCTS

MATERIAL:

The Subcontractor shall furnish all materials, instruments, and equipment (except government furnished material and equipment) required to perform the pressure tests. All test equipment shall have been calibrated within 30 days of use, be in good working order and have gauges accurate to within ± 3.0% of span.

PROCEDURE:

General: Testing shall be performed after fabrication and before equipment is initially placed in service. All pressure joints (including welds) except those noted otherwise shall be exposed during tests.

As a result of testing, those welds, joints, surfaces, areas, etc., found to be unacceptable shall be repaired and the item retested. The Contractor's Representative shall be notified of any test failures. This procedure shall continue until the item is shown to be acceptable.

When conditions require that a pressure test be maintained for a period of time during which the testing medium in the system would be subject to thermal expansion, provisions shall be made for the relief of the excess pressure so caused.

Short pieces of piping which must be removed to permit installation of a blind flange or slip blind shall be tested separately.

All instrument and purge lines directly connected to process or utility piping or equipment through the first block valve shall be tested with the piping and equipment under test and subject to the same procedures. Instruments shall be disconnected from the instrument line by breaking the union or tube fitting after the first block valve to prevent damage to the instruments from possible valve leakage.

After satisfactory completion of a test, all temporary blinds are to be removed. Valves, short pieces of piping and any other items removed for the test are to be reinstalled with proper gasketing. Valves that are closed solely for testing shall be opened.

Water line shall be hydrostatic pressure tested. In addition an In-process examination, or in-service test shall be done on all air lines.

No pressurization of existing vessels is allowed during testing.

<u>Water, and Compressed Air, Hydrostatic Pressure Testing</u>: All pressure testing shall be hydrostatic in accordance with ANSI B31.3. Final connections will be in-service leak checked. No pressure testing of piping components located inside the tank is required.

Compressed air piping shall be hydrostatically pressure tested at 150 psig.

Water piping shall be pressure tested at 125 psig.

Test pressure shall be maintained for a sufficient time to inspect all joints, with a minimum of 10 min.

Care shall be taken to ensure the use of plant treated water for these tests. Maximum allowable chloride content of water shall be 35 ppm. A suitable filter with 20 micron mesh shall be provided in the fill line to the systems should foreign matter such as sand, rust, or other particles be in evidence in the proposed test water. Disposal of test water shall be as directed by the Contractor.

Vents or other connections shall be opened to eliminate air from lines which are to receive a hydrostatic test. Lines shall be thoroughly filled before test pressure is applied. Vents shall be opened when draining systems following the hydrotest.

Test pressure readings shall be taken at the lowest point of the line or system under test.

All instruments which might be damaged during the test shall be disconnected.

After successful completion of the test, all lines shall be blown dry with clean oil-free air.

The Subcontractor shall submit a written hydrostatic pressure testing procedure to be approved by the Contractor prior to beginning a test. The procedure shall include a test record to be completed after the test. See Test Records Section of this specification.

Upon completion of hydro-testing all air line shall be blow down to remove moisture.

TEST RECORDS:

Accurate test records shall be kept on each system tested. Each test shall be witnessed and approved by the Contractor's Representative. The Contractor's Representative shall be notified forty-eight (48) hrs prior to beginning a test.

Test Reports shall include for each Test and/or Retest:

Identification of system (including all line numbers)

Testing medium

Test pressure and pressure steps

Date and Contractor's approval

Results

Contractor's Representative approval space

Repairs and retests

Calibration dates of testing and equipment.

FIELD QUALITY CONTROL:

Contractor Inspections: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 15600

SECTION 15801--AIR DISTRIBUTION SYSTEM

PART 1--GENERAL

SUMMARY:

This section includes, but is not limited to tank exhaust air ventilation system and all duct system equipment as shown on the subcontract drawings and specified herein. The Subcontractor shall furnish and install all equipment, materials, and supplies, and perform all work and operations necessary for the construction of the tank exhaust air vent system as shown on the subcontract drawings and specified herein. Upon completing installation, the Subcontractor shall operate and test the system as specified hereinafter to verify that the system is properly installed and operates as required.

Section Includes: Work includes, but is not limited to:

The Subcontractor shall furnish all labor, materials, equipment and services necessary to perform the installation of the tank exhaust air system.

SYSTEM DESCRIPTION:

The tank exhaust air system provides ventilation to the tank during sparging operations. The ventilation system consists of the following items; mist eliminator (PVC), inline duct heats, HEPA Filter, Granulated Activated Carbon Absorber, blower, ducting and exhaust stack.

Design Requirements: System components shall be designed to operate at the given design parameters at an altitude of 5,000 ft.

SUBMITTALS:

See the Vendor Data Schedule.

QUALITY CONTROL:

The Subcontractor shall comply with the requirements of the current revision of the following codes and standards, as referenced and specified in this section.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A569	Standard Specification for Sheet Steel Hot-Rolled
ASTM C534	Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC. (SMACNA)

SMACNA	HVAC Duct Construction Standards
SMACNA	Rectangular Industrial Duct Construction Standards
SMACNA	Round Industrial Duct Construction Standards

INTERNATIONAL MECHANICAL CODE (IMC)

PART 2--PRODUCTS

GENERAL:

Blower: Blower shall be a Cincinnati Fan Model PB-15A, Direct Drive, Arrangement 4, 8 inch inlet clockwise rotation and bottom horizontal discharge, the wheel is 16.5 inch diameter X 4 3/8 inch wide and the blower shall be skid mounded. 12 inch O.D. Inlet and 10 inch O.D. outlet. The motor shall be 10 HP, @ 3450 RPM, 3 phase, 60 Hz, 208 VAC, rated for use with variable speed drive (VFD), 2500 CFM @ 10 inch WG SP. Motor electrical characteristics shall be 208 VAC, 3 phase, 60 Hz.

Flanged Duct Heaters: Duct heater(s) shall be INDEECO cat number 166X-Custom. Heaters shall be rated at 10.7 KW and have 208 volt, 3 phase, 60 Hz electrical characteristics. Heater shall tubular fins, rated for minimum Velocity 964.2 (SFPM), 3/8 inch thick 304 SS mounting plate, NEMA-4X 304 SS panel, SS Finned tubular elements with gas tight fittings, 304 SS Frame Element Support Brackets, 1 " tk. terminal box insulation, 2 Hubs (1) ½ in. NPT, (1) 1 in. NPT quantity. In addition, the heaters shall have the following features:

High –Limit thermocouple mounted in the outlet and attached to one element

Elements to be installed into heater frame with 304 Stainless Steel (SS) compression fittings

Terminal housing is isolated from the duct with the stainless steel compression fittings

Airflow direction is left to right looking at terminal housing

Finned tubular process air heater may be mounted either horizontally of vertically

Finned tubular process air heaters have individually field replaceable elements

Pressure drop through the heater is approximately 0.08 inches of water column.

PVC VERTICAL MIST ELIMINATOR:

Mist Eliminator shall be inline type, vertical arrangement, double stage inline mist eliminator sized for 2000 CFM @ 1.5" SP Features include (2) 2" thick removable polypropylene mesh pads, mesh pads drainage utilizing gravity drain back through mist eliminator, 16 inch diameter flanged inlet and 12 inch diameter flanged outlet, (2) removable spray headers and spray nozzles (spiral jet spray nozzles) each sized to deliver 5.3 GPM @ 10 psi. Pressure element fitting on the inlet and outlet of the mist eliminator. Material used in construction shall be Type II, Grade 1 high impact gray 1/4" and 3/8" thick corrosion resistant PVC. PVC flange shall be 1 1/2" X 3/4" Wide flange Inline mist eliminator pads shall be 99% efficient for removal of mist to 6 microns (MW-4) Mesh pads. Mist Eliminator shall be by Midwest Air Products Co. Inc., Telephone (800) 214-7716.

DUCTWORK:

All duct material shall be in accordance with this specification and the appropriate SMACNA Duct Construction Standard (Round), for the pressure classification shown on the subcontract drawings. Unless otherwise shown on the subcontract drawings, material gage, duct reinforcing, and connections shall be in accordance with the applicable SMACNA Standard for the given pressure classification. The abrasive particulate classification for the duct system is Class 1. Specific weight of particulate to be conveyed in the duct system is 1.1 lb/cubic ft.

Duct system material substitutions shall be approved by the contractor's representative. In the case of a substitution, system flow characteristics, and integrity for an "or equal" substitution are all equal to or better than the system as designed and specified.

CS Duct Materials: Duct material for CS designated systems shall be hot rolled steel sheet in accordance with ASTM A569 Commercial Quality, or hot rolled steel plate in accordance with ASTM A569

Flex Duct: Where shown on the subcontract drawings, the Subcontractor shall supply and install flexible duct for connection from hard duct systems to equipment. Flex-duct shall be made of medium weight Santoprene ® thermoplastic rubber wall hose construction reinforced with a spring steel wire helix. Pressure rating 3.5 psi and 5.36 in Hg Negative pressure Temperature Range -40° F to 275° F, End Finish Plain cut, Standard lengths 25 & 50 Feet, or approved equal. Flex duct shall be as by Flexaust Company Inc., IN 46581-4275 (Ph 800 343-0428.)

Clamps: Quick release Hose Duct Clamps, electrogalvanized steel band adjustable over a range of approximately ½ inch diameter. Sized per drawings.

PVC Ducting: Ducting shall be Sch 40 PVC Pipe conforming to ASTM D 2466.

PVC Elbows: All 90° elbow shall be Sch 40 and shall be long radius conforming to ASTM D 2466.

Wire Rope: 1/4" Fiber cord 6 X 19 regular Steel, break strength 5480 lbs.

Wire Rope Clips: Wire rope clips shall be Crosby clips Galvanized G-450 clips.

DUCTWORK HANGERS AND SUPPORTS:

Unless otherwise shown on the subcontract drawings, ducts shall be supported with materials in accordance with SMACNA "HVAC Duct Construction Standards. Hangers and supports for flexible ducts shall be in accordance with SMACNA "Industrial Duct Construction Standards."

DUCTWORK INSULATION:

Above Ground: Flexible ducts shall be insulated as called out on contractor drawing on the outside with flexible glass fiber blanket. Fiber Glass Duct Wrap Insulation with a minimum installed R-Value 5.2 of, and a Type Class I Vinyl facing.

Insulation shall be furnished with a factory-applied facing with a composite UL rating.

Insulation of the type detailed in the subcontract drawings shall be installed where shown on the subcontract drawings. No asbestos will be allowed. All insulation shall meet NFPA Standards for low fire hazard classification of: Flame Spread - 25 maximum, Fuel Contributed - 50 maximum, and Smoke Developed - 50 maximum.

Duct insulation joints shall be seal with pressure sensitive tape as recommend by the duct insulation manufacturer.

PART 3--EXECUTION

INSTALLATION OF DUCTWORK:

Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight and capable of performing each indicated service. Install each run with a minimum of joints. Align ductwork accurately at connections. Coordinate duct installation with installation of accessories, coil frames, equipment, controls, and other associated work of the ductwork system. Installation shall be in accordance with SMACNA Duct Construction Standards (Round,) and the International Mechanical Code.

Plastic Pipe Joints: PVC Plastic pipe joints shall be made in strict accordance with written instructions of plastic pipe and fitting manufacturer. Joints shall be solvent welded in accordance with the manufacturer's recommendation and installation instructions.

Carbon Steel Round Duct Joints: Duct joints shall be constructed in accordance with SMACNA Round Industrial Duct Construction Standards. All duct joints shall be welded in accordance with Specification 05062 Sheet Metal Welding. Flanged duct joints shall be used for connection to equipment.

FIELD QUALITY CONTROL:

Contractor Supplied Testing: NA.

Subcontractor Supplied Testing: Verify installation conforms to subcontract drawings. Verify operation of exhaust air fan and system components prior to final tank connection.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 15801

SECTION 16000--ELECTRICAL GENERAL PROVISIONS

PART 1--GENERAL

SUMMARY:

The Subcontractor shall provide, install, terminate, and test all the systems as described in the specification and shown on the drawings to make complete and operational electrical systems.

Section Includes, but is not limited to:

1. Power distribution including feeders, panels, and safety switches
2. Normal lighting including lighting controls
3. Fire Alarm System (FAS), Emergency Communications (ECS), telephone (TELE), and data systems
4. Power system grounding, data, and communication system grounding.

Related Sections:

15801 Air Distribution System

REFERENCES:

The following documents, including others referenced therein, form part of this section to the extent designated herein. Unless otherwise indicated, use the latest edition in effect as of the date of these specifications.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C-2	National Electrical Safety Code (NESC)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA-70	National Electrical Code (NEC)
NFPA-101	Life Safety Code

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Subpart S	OSHA Electrical Safety

FACTORY MUTUAL

NATIONAL RECOGNIZED TESTING LABORATORIES (NRTL)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

CANADIAN STANDARDS ASSOCIATION (CSA)

UNDERWRITERS' LABORATORIES, INC. (UL)

UL 486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors

SUBMITTALS:

See Section 01300, Submittals, other electrical sections and the Vendor Data Schedule for submittal requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with the following codes and standards, except as modified herein:

Underwriters Laboratories (UL): All materials, appliances, equipment or devices shall conform to the applicable standards of Underwriters Laboratories, Inc. All material, appliances, equipment or devices shall be listed and/or labeled by UL or other nationally recognized testing laboratories such as the CSA.

Completed electrical system shall conform to applicable provisions of the Special Conditions, the Technical Specification, and the subcontract drawings.

PART 2--PRODUCTS

GENERAL:

Furnish all labor, materials, equipment and appliances required to complete the installation of the complete electrical systems. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the National Electrical Code (NEC), the National Electrical Safety Code (NESC), Occupational Safety and Health Administration (OSHA), and the terms and conditions of the electrical utility. All modifications required by these codes, rules, regulations, and authorities shall be made by the Subcontractor without additional charge to the Contractor.

MANUFACTURERS:

Where multiple units of a product are required for the electrical work, provide identical products by the same manufacturer without variations except for sizes and similar variations as indicated.

MATERIALS:

Except as otherwise indicated, furnish new electrical products, free of defects and harmful deterioration at the time of installation. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of the product, or required by governing regulations.

Unless otherwise indicated by the drawings or specifications or approved in writing, the materials and/or equipment furnished under these specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment, and shall be the manufacturer's standard design.

ENVIRONMENTAL CONDITIONS:

Climatic and Geographic Site Conditions

Site Elevation	5,000 feet
Barometric Pressure	12.27 psia
Relative Humidity	90% max. at 30° F (–1.1° C) dry bulb
	15% min. at 60° F (+15.5° C) dry bulb
Temperature	+104° F (+40° C) max.
	-40° F (-40° C) min.
Snow Load	30 psf
Wind Forces	80 mph Exposure Class “C”

NEMA 3R, 4, 4X or 12, enclosures will be provided for all equipment unless noted otherwise on drawings. See Section 16810 for additional enclosure requirements for the environmental conditions.

Labeling: Install permanent labels on all electrical panels, cabinets, disconnects, motor starters, major equipment or components, receptacles, and switches. See Section 16195--Electrical Identification for labeling requirements.

PART 3--EXECUTION

SEQUENCING/SCHEDULING:

General: It is recognized that the subcontract documents are diagrammatic in showing certain physical relationships which must be established within the electrical work and in its interface with other work, including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Subcontractor.

Arrange electrical work in a neat, well organized manner with conduit and similar services running parallel with the primary lines of the building construction, and with a minimum of 7 ft-0 in. overhead clearance.

Locate operating and control equipment properly to provide easy access, and working clearance in accordance with the NEC.

Advise other trades of openings or clearances required in their work for the subsequent move-in and assembly of large units of electrical equipment.

Electrical connections shall be tightened to torque specifications stated by the equipment manufacturer. If manufacturer has no recommended torque value, tighten as per UL 486A.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing: Upon completing installation of all systems and equipment, but prior to project close out, the Subcontractor shall conduct an operational test of all equipment, controls and devices installed or modified by the Subcontractor. The operational test shall include phase rotation test for all rotating equipment and new or refed panel boards. All equipment shall test satisfactory or be repaired or replaced at no additional cost to the Contractor.

The Subcontractor shall test all devices in the presence of the Contractor's Representative. Subcontractor shall coordinate testing with the Contractor and schedule testing a minimum of 2 weeks in advance of the test. The Subcontractor shall inform the Contractor in writing of the scheduled test to allow the Contractor to designate the Contractor's Representative. This operational testing is in addition to testing required in separate sections of this specification.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16000

SECTION 16810--INSTRUMENTATION

PART 1--GENERAL

SUMMARY:

This section includes process measurement and control instruments; primary elements and control valves; and twisted-pair cables, connectors, and terminal equipment.

Section Includes but is not limited to the following:

PM-2A Tank Sparging project Instrumentation & Control system

This section will cover the requirements for the installed instrumentation and the programming/wiring necessary to achieve the system's necessary control functions.

Related Sections:

15201 Process Piping (ASME B31.3 Normal Fluid Service)
16000 Electrical General Provisions
16110 Electrical Raceways
16120 Cable, Wire, Connectors and Miscellaneous Devices
16195 Electrical Identification

Underwriters Laboratories (UL): All materials, appliances, equipment or devices shall conform to the applicable standards of Underwriters Laboratories, Inc. All material, appliances, equipment or devices shall be listed and/or labeled by UL or other nationally recognized testing laboratories such as the CSA.

Completed electrical system shall conform to applicable provisions of the Special Conditions, the Technical Specification, and the subcontract drawings.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein:

DEPARTMENT OF ENERGY

DOE-ID Architectural Engineering Standards Section 1665

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A-269 Seamless & Welded Austenitic Stainless Steel Tubing for General Service

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum)
NEMA ICS 1	General Standards for Industrial Control and Systems

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

MC 96.1	Temperature Measurement Thermocouples

INSTRUMENTATION, SYSTEMS AND AUTOMATION SOCIETY (ISA)

ISA 5.1	Instrumentation Symbols and Identification
ISA-20-1981	Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves
ISA 50.1	Compatibility of Analog Signals for Electronic Industrial Process Instruments

FEDERAL SPECIFICATIONS

TT-E-509	Odorless Smokeless Alkyd Enamel
TT-E-545	Enamel Undercoater
TT-P-30	Odorless Alkyd Flat Paint
TT-S-179	Surface Sealer

SYSTEM DESCRIPTION:

The PM-2A I&C system will control and monitor the evacuation of a large capacity tank (currently tank V-14). The primary task of the system will monitor the exit air flow from the tank and control the speed of a blower to maintain the internal tank pressure at -0.5 " H_2O (i.e. Vacuum). The system will contain a series of redundant interlocks to shut off the supply air flow to ensure that the tank is never pressurized.

Since the evacuated air is expected to be of high humidity, the secondary function of the system will be to heat the evacuated air before filtration and exhausting to the atmosphere. In order to avoid equipment damage to the heater, the system will contain flow and filter pressure interlocks (loss of flow) to automatically shut off the heater upon loss of flow.

The third function of the system will be to monitor the relative humidity of the air prior to it entering the granulated activated carbon (GAC) filter (for VOC filtration). This must be monitored to protect the GAC from high humidity air.

Design Requirements: See Appendix A.

Performance Requirements: See Appendix A, B.

SUBMITTALS:

Appendix C.

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements. Submittals include, but are not limited to the following:

Installer's Certification: The Subcontractor shall submit a certification of the installer's experience required under Quality Control.

Product Data: Vendor data, as required by the Vendor Data Schedule, for materials and equipment to be furnished by the Subcontractor shall be submitted by the Subcontractor for approval. The data submitted shall be in such detail as to clearly illustrate the materials and equipment, including components and the fabrication thereof that the Subcontractor proposes to furnish.

Shop Drawings: Copies of shop drawings as required by the Vendor Data Schedule for materials and equipment to be furnished by the Subcontractor shall be submitted by the Subcontractor for approval. The data submitted shall be in such detail as to clearly illustrate the materials and equipment, including components and the fabrication thereof that the Subcontractor proposes to furnish.

Shop Tests: For any prefabricated assemblies (ex. The instrumentation and control panel or the pressure transmitter panel) the Subcontractor or his agents shall perform the following testing at the shop: (note: the following testing will also be performed onsite as part of the system operational testing. By pretesting, at the shop the risk of any critical malfunctions is reduced.)

Prior to installation any prefabricated subassemblies shall be inspected for conformance, And continuity tested. Test by applying power, simulating analog inputs (4-20 mA or pressure), and verifying appropriate outputs (DC current outputs, relay operations, alarms).

Arrangement Drawings: Copies of arrangement drawings as required by the Vendor Data Schedule for material and equipment to be furnished by the Subcontractor shall be submitted by the Subcontractor for approval. The arrangement drawings submitted shall be in such detail as to clearly illustrate the arrangement of the components.

Equipment and Wire Lists: The Subcontractor shall submit an equipment, cable and wire list(s) for Contractor approval based on Label requirements listed.

Wire and Cable Tests: The Subcontractor shall furnish copies of wire and cable test results and reports required in Part 3 - Execution.

Government Furnished Material: The Subcontractor shall turn over any documentation packaged with government furnished items.

Operation and Maintenance Manuals: The Subcontractor shall furnish copies of installation, operating and maintenance manuals for new equipment. Such data shall be prepared by the manufacturers of the equipment that is to be furnished and installed under these specifications.

Manuals shall be complete and shall include operating instructions and special test procedures or instructions recommended by the manufacturer, maintenance procedures, a complete parts list and recommended list of spare parts for normal expected maintenance.

QUALITY CONTROL:

Qualifications: Engage Installers with a minimum of three years of documented instrumentation and control installation experience.

Regulatory Requirements, Codes and Standards: Comply with the provisions of the following codes and standards unless otherwise specified herein.

National Fire Protection Association National Electrical Code (NFPA 70)

Code of Federal Regulations (CFR) 29 CFR 1926 Construction Industry Safety Standards

Code of Federal Regulations (CFR) 29 CFR 1910 General Industry Safety Standards

DELIVERY, STORAGE AND HANDLING:

The Differential pressure and the flow station transmitters are extremely sensitive devices and need to be protected from spurious air currents. Leave their protective features in place (caps, zero pressure devices) until just prior to installation and if possible, after installation.

STORAGE AND PROTECTION:

Provide site and warehouse storage facilities for equipment.

Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions or have temperature related storage limitations.

Cover panels and other elements that are exposed to dusty construction environments.

SITE CONDITIONS:

Environmental Requirements: Unless noted otherwise, equipment and enclosures shall be rated at least:

Freestanding Panel
Outdoors: NEMA 4X

Junction/Pull Boxes
Outdoors: NEMA 12

Field Devices
Outdoors: NEMA 4X

Higher levels of protection may be used in place of level specified above. For example, NEMA 12 in place of NEMA 1.

ENVIRONMENTAL CONDITIONS:

Environmental conditions are defined below:

Inside Enclosure:
Temperature: 32 to 90 degrees F: operating
0 to 90 degrees F: not operating
Relative Humidity: 5 to 95 percent non-condensing
NEC Classification: Non-hazardous windblown dust and rain

Outside:
Temperature: 32 to 100 degrees F: operating
0 to 100 degrees F: not operating
Relative Humidity: 5 to 95 percent non-condensing
NEC Classification: Non-hazardous

Field Measurements: The Subcontractor shall field verify dimensions prior to fabrication.

SEQUENCING/SCHEDULING:

None.

WARRANTY:

Provide manufacturer's warranties documentation.

SYSTEM START UP:

Prior to commissioning the system:

1. Connect the 3 phase blower motor and VFD (Variable Frequency Drive), bump the motor using the VFD and verify proper rotation
2. Calibrate all instruments and meters.

EXTRA MATERIALS (SPARE PARTS):

Provide Spares parts for each type of instrument (including meters and chart recorder) and for the 24V power supply.

PART 2--PRODUCTS

General: Furnish all labor, materials (except government furnished material), equipment and appliances required to complete the installation of the complete instrumentation systems. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the National Electrical Code NFPA 70 and Occupational Safety and Health Administration (OSHA). All modifications required by these codes, rules, regulations, and authorities shall be made by the Subcontractor without additional charge to the Contractor.

All materials, equipment and installations shall be accessible for inspection by the Contractor or his designated representative during any phase of construction, fabrication, manufacture and erection or testing.

MANUFACTURERS:

Subject to compliance with the stated requirements, provide products of well established, reputable manufacturers that have been serving the applicable markets for a number of years and are expected to be in the business for at least the life of the project. It is very important that the equipment manufacturer be available to support the instrument and be able to provide a replacement.

Tubing Materials: See Section 15201 for tubing materials. Any tube fittings specified on the drawings may not be substituted. All tubing shall be of the sizes shown on the drawings.

Process Measurement and Control Instruments: Subject to compliance with requirements, provide process measurement and control instruments as specified in Attachment A.

Primary Elements and Control Valves: Subject to compliance with requirements, provide primary elements and control valves as specified in Attachment A.

Conductors, Cables, Connectors, And Terminal Equipment:

Conductors: Stranded tinned copper.

Unshielded Twisted Pair (UTP) Cable: Comply with NEC listing requirements. Thermoplastic or PVC-insulated, individually twisted pairs of conductors; No. 18 AWG, color-coded; enclosed in PVC jacket. Number of pairs as specified on the drawings.

Single Pair Shielded Twisted Signal Cable (TSP) and Shielded Twisted 3 Conductor Signal Cable (TS3): Comply with NEC listing requirements. Thermoplastic or PVC-insulated, individually twisted pairs of conductors; No. 18 AWG, color-coded, overall aluminum and polyester shield and minimum No. 22 AWG, tinned or solid-copper drain wire; enclosed in PVC jacket.

Connectors and Splices: Factory-fabricated connectors of size, ampacity rating, material, type, and class for application and service indicated. Splices are NOT allowed unless specifically shown on the drawings.

SOURCE QUALITY CONTROL:

Factory Tests: The Subcontractor or his agents shall perform the following at the factory, shop or onsite:

No special testing required. Prior to installation any prefabricated subassemblies shall be inspected for conformance, continuity tested and functionally verified.

PART 3--EXECUTION

Dimension Verification: The Subcontractor shall field verify dimensions prior to fabrication.

COORDINATION OF INSTRUMENTATION WORK:

General Requirements: Materials and equipment shall be erected or installed only by qualified personnel who are regularly engaged in the trades required to complete the work. The subcontract drawings show the general arrangement and space allocation of the equipment specified. It shall be the Subcontractor's responsibility to field locate the required equipment approximately as shown on the design drawings and to field route any required conduit runs. The contractor shall also have the flexibility to specify the actual equipment meeting the requirements set forth. The contractor shall verify any changes in conditions or rearrangements necessary because of substitutions for specified materials or equipment. Where rearrangements are necessary the Subcontractor shall, before construction or installation, prepare and submit drawings of the proposed rearrangement for approval. The drawings and changes shall be made at no cost to the Contractor.

Workmanship: The Subcontractor shall perform structural cutting, fitting, patching, repairing and associated work necessary for installation of instrumentation, equipment, wiring and electrical conduits. No major cuts or holes, not shown on the drawings, shall be made without prior approval of the Contractor. After the equipment and/or conduit is installed, all exposed holes, cracks and other defects shall be neatly patched and the patched areas shall match the adjoining materials and finish.

Arrange work in a neat, well organized manner with conduit and similar services running parallel with the primary lines of the building construction, and with a minimum of 7 ft-0 in. overhead clearance where possible.

Locate operating and control equipment properly to provide easy access, and arrange entire instrumentation work with adequate access for operation and maintenance.

Advise other trades of openings or clearances required in their work for the subsequent move-in and assembly of large units of equipment.

Electrical connections shall be tightened to torque specifications stated by the equipment manufacturer.

Ensure instruments and electrical equipment are mounted per manufacturer's recommendations using the provided mounting holes, brackets and hardware.

Conduit Installation: Install/support per NEC requirements. Conduit sizes as specified on any drawings are minimums and may be substituted for larger sizes as desired. Instrumentation conduit runs may be combined as needed. Power, Control and Instrumentation wires (cables) must be run in separate conduits (120 V control may share the same conduit as instrumentation wiring cables).

Tubing Installation: See Section 15201 for tubing installation requirements. The Subcontractor is responsible for providing all tubing and tubing fittings required to complete the installation. Couplings are not shown on the drawings and shall be supplied by the Subcontractor as required. Tubing fittings shall be by a single approved manufacturer.

Tubing Support: Tubing support shall be with tube clamps, Unistrut P2010 in conjunction with steel channel. Unistrut type P2010 one hole clamps alone may be used for locations that channel is not feasible. The installation shall support the tubing without sagging and shall clear the work of other trades.

Wiring Methods: Install cables using techniques, practices, and methods that are consistent with signal rating of components and that ensure signal performance of completed and linked signal paths, end to end.

Install cables without damaging conductors, shield, or jacket. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

Pull cables without exceeding cable manufacturer's recommended pulling tensions. Pull cables simultaneously if more than one is being installed in same raceway. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips that will not damage media or raceway.

Wiring within Panel Enclosures: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

Separation of Wires: Comply with TIA/EIA-569-A rules for separating unshielded copper voice and signal cabling from potential EMI sources, including electrical power lines and equipment.

New wire in existing control panels and junction boxes shall be routed with existing wire bundles and shall use existing wire ducts where possible. Wiring shall also be separated by voltage. The 120 VAC shall be routed separately from all other circuits. Parallel runs (of 120 VAC and other circuits) shall be separated by at least 3 inches. If it becomes necessary to bring a 120 VAC bundle across a non-120 VAC bundle, the crossing shall be made at a 90 degree angle. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components. Splicing or tapping of wires is not allowed in panels.

GROUNDING:

Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

Bond shields and drain conductors to ground at only one point in each circuit.

LABELING:

Equipment Labeling: Equipment identifiers shall be in agreement with the system P&ID drawing. Install the engraved labels as shown on the drawings. Identifying items with marking pens, adhesive tape, embossed plastic or metal tape, or similar type means is not acceptable.

Labels shall be laminated phenolic or plastic colored black with white engraved letters.

Unless shown otherwise on the drawings equipment mounted outside shall be labeled with a stainless steel tag of a thickness not less than 19 gauge with legend letters not less than 1/4 inch tall.

If not shown on the drawings equipment nametags shall be installed by one of the following means:

1. Hung off equipment with 1/16 inch stainless steel bead chain or cable
2. If inside, attached to equipment or immediately next to equipment using a suitable adhesive such as General Electric RTV silicone rubber. They may also be attached to equipment or immediately next to equipment using bolts, screws or rivets
3. If outside, attached to equipment or immediately next to equipment using bolts, screws or rivets.

Wire Labeling: All conductors or cables shall be identified with white heat shrink tubing with black typed on minimum 3/32 inch letters with non-smear ink such as Brady-321, Brady-322 or approved equal. Hand lettered labels shall not be used. All conductors or cables shall be labeled with point-to-point destination. Wire label legends shall follow an origin/destination practice. For example consider a single conductor between terminal 8 on TB9 in CP-YDJ-963 and terminal A on instrument FSL-YDJ-3. At CP-YDJ-963 the label would be 8/ FSL-YDJ-3-A and at FSL-YDJ-3 the label would be A/CP-YDJ-963-TB9-8. If legend length would exceed label length it is acceptable to drop the sub area (YDJ), if used, from the legend.

FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: The Subcontractor or his agents shall perform the following on-site tests:

Electrical Continuity: After conductor connectors are installed and conductors are labeled, but prior to termination to terminals or devices, an electrical continuity test shall be performed on each conductor using a battery powered buzzer or ohmmeter to determine that all power, control, grounding and other conductors are properly installed and identified. The Subcontractor shall provide the Test Data Submittal Sheets. List all conductors tested on required test data submittal sheets.

Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

Tubing Leak Testing: Pressurize the tubing to a pressure to approximately 90% of the maximum rating of the transmitter.

"Snoop test" all connections for leaks from the transmitter to the pressure source.

Note: "Snoop test" refers to the coating of all new fittings or joints with a liquid that provides bubbling action if exposed to a gas system leak such as Nupro Company SNOOP liquid leak detector. The joints or fitting shall be observed for a period of 30 seconds minimum for the formation of bubbles or any other indications of leakage around the entire circumference of the joints. Any sign of leaking will be stopped by the Subcontractor and the fitting retested. Any repair of leakage beyond tightening fittings must be approved by the Contractor.

Contractor Inspection and Testing: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications. All equipment (except GFE) shall test satisfactory or be repaired or replaced at no additional cost to the Contractor.

Subsystem Testing:

Blower Motor Speed Control Variable Frequency Drive: Program per manufacturer's instructions and Appendix B.

Blower Motor Rotation Test: After blower system installation, verify proper rotation by "jogging" the blower motor with the motor driver control and verify proper motor rotation. If incorrect, reverse any 2 of the 3 blower motor connections.

Solenoid Valve Operational Test: Connect a 4-20mA current source to the inputs for DPIC-10a and DPI-10b (simultaneously). With the control cabinet energized, vary the current input and verify the solenoid valve SV-10 opens at 11.28 mA and closed at 11.68mA. (These values correspond to the tank pressure setpoints of -.45 "H_2O for opening and -.20 "H_2O for closing). Caution, do not operate the blower or pressurize the tank.

Sparge Motor Drive Test: Energize the Sparge Motor Drives, set-up the motor drivers per the manufacturer's instructions. Verify that the sparge tubes are turning in the desired direction. Vary the speed control (VR1) at the Instrumentation Panel, verify that the rotation speed changes.

System Level Operational Tests:

Power the system.

Tank Pressure Control Test: For the following test have a person free to immediately activate the Emergency stop switch at the control cabinet in case of a problem.

Open Loop Control: Disconnect the field instrument inputs and connect a 4-20mA current source to the inputs for DPIC-10a and DPI-10b (simultaneously).

With the control cabinet energized, set the current input to 11.28 $\pm$ .05 mA (corresponding to -.45 "H_2O). Turn on the operator On/Off key switch.

Verify that the blower motor slowly increases in speed.

Decrease the current input towards 11.20 mA (corresponding to -.50 "H_2O).

Verify that the blower speed stops increasing.

Decrease the current input even further past 11.20 mA (towards 10.00 mA).

Verify that the blower speed starts decreasing.

Closed Loop Control: Reconnect the field instruments to DPIC-10a and DPI-10b. Turn on the air compressor. Turn on the operator switch, the blower will start automatically.

Verify.

As soon as the tank pressure has dropped down to-.45 “H_2O (i.e. vacuum), solenoid valve SV-10 will open.

Verify.

Turn off the blower. When the tank pressure rises to -.20 “H_2O solenoid valve SV-10 will close.

Verify.

Tune the DPIC-10a controller.

Heater Tests: Restart the system, vary the humidity control setpoint above and below the actual humidity value indicated on HI-10. Verify that the heater output changes appropriately. Tune the HIC-10 controller.

Heater High Temp Cutout: Change the humidity control setpoint significantly below the actual humidity to cause the heater to begin to put out more heat. Verify that when the heated air temperature reaches>96^{o} F the alarm on TI-10 is activated and the heater is disabled.

System Alarm Tests: With the system operating in a steady state condition temporarily reprogram the panel meter alarm trip points to activate the system alarms. Verify. Restore alarm trip points when done.

INSTRUMENTATION:

See Appendices A & B for instrument requirements.

After instrument selection complete ISA-20-1981 instrument forms S20.20a, S20.13a, (or S20-14b), S20-20b, S20-55, S20-41a, and S20.2a as applicable. Copies of the referenced forms are included in Appendix C.

END OF SECTION 16810

Attachment 3

Design Calculations and Analysis

Document ID: EDF-5558
Revision ID: 2
Effective Date: 05/19/05

Engineering Design File

Project No. 24830; 23095

TANK V-14 AIR STRIPPING CALCULATIONS AND PROCESS SIZING

Idaho Cleanup Project

The Idaho Cleanup Project is operated for the U.S. Department of Energy by CH2M•WG Idaho, LLC

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431.02
01/30/2003
Rev. 11

ENGINEERING DESIGN FILE

EDF No.: 5558 EDF Rev. No.: 2 Project File No.: 24830; 23095

1. Title: Tank V-14 Air Stripping Calculations and Process Sizing

2. Index Codes:
Building/Type WAG 5 SSC ID V-14 Site Area ICDF

3. NPH Performance Category: ______ or ☒ N/A

4. EDF Safety Category: ______ or ☒ N/A SCC Safety Category: N/A or ☒ N/A

5. Summary:

The overall design is to provide a treatment system to remove tetrachloroethylene from tank V-14 by air sparging. This Engineering Design File evaluates the process and operating parameters for the treatment system. The nominal sparger design flow of 2,000 scfm is recommended; this provides the design basis for most of the system. It is also recommended to use the radial flow GAC unit. A flow providing key parameters is provided. The PCE is predicted to be removed in less than one day at the nominal flow rate based on the scale-up and theory.

6. Review (R) and Approval (A) and Acceptance (Ac) Signatures:
(See instructions for definitions of terms and significance of signatures.)

	R/A	Typed Name/Organization	Signature	Date
Performer/ Author	N/A	S.C. Ashworth	*Samuel C. Ashworth*, via e-mail	05/06/05
Technical Checker	R	D.R. Tyson	*David R. Tyson*, via e-mail	05/09/05
Independent Peer Reviewer (if applicable)	R			
Approver	A	D.F. Nickelson	*David F. Nickelson*, via e-mail	05/10/05
Requestor (if applicable)	Ac	C.J. Hurst	*C. Justin Hurst*, via e-mail	05/10/05
Reviewer	R			
Reviewer	R			
Doc. Control		BECKY METCALF	Becky Metcalf	5-19-05

7. Distribution: (Name and Mail Stop) S.C.Ashworth 3670, B.E. Bonnema 3670, K.C. DeCoria 3650, C.J. Hurst 3670, D.R.Tyson 9206, D.F. Nickelson 3670, A.K. Yonk 9206

8. Does document contain sensitive unclassified information? ☐ Yes ☒ No
If Yes, what category:

9. Can document be externally distributed? x Yes No

10. Uniform File Code: 0250; 6102 Disposition Authority: A16-3-a; ENV!-h-1
Record Retention Period: See LST-9

11. For QA Records Classification Only: ☒ Lifetime ☐ Nonpermanent ☐ Permanent
Item and activity to which the QA Record apply:

12. NRC related? ☐ Yes ☒ No

431.02
01/30/2003
Rev. 11

ENGINEERING DESIGN FILE

EDF No.: 5558 EDF Rev. No.: 2 Project File No.: 24830; 23095

1. Title: Tank V-14 Air Stripping Calculations and Process Sizing

2. Index Codes:
Building/Type WAG 5 SSC ID V-14 Site Area ICDF

13. Registered Professional Engineer's Stamp (if required)

CONTENTS

FIGURES

TABLES

ACRONYMS

ICDF	Idaho CERCLA Disposal Facility
GAC	granular activated carbon
HEPA	high-efficiency particulate air
IDLH	immediate danger to life and health
LDR	land disposal restriction
PCE	tetrachloroethylene (perchloroethylene)
SCFM	standard cubic feet per minute
STEL	Short Term Exposure Limit
TAN	Test Area North
TFR	Technical and Functional Requirements
TLV	threshold limit value
TSF	Technical Support Facility
TWA	time weighted average
UST	underground storage tank
VOC	volatile organic compound
WAC	Waste Acceptance Criteria

NOMENCLATURE

a_i	Specific surface area, L^2/L^3 (L^2/M for $k_s a$)
A	Area, L^2
c	Total concentration, mol/L^3, speed of sound L/t
c_p	Heat capacity, FL/mol/T
C	Capacitance, in^3/psi (note, specialized unit for process control)
C_b	Bending length, L
C_d	Drag coefficient
C_i	Concentration of i in liquid, M/L
C_i^v	Virtual concentration of i M/L
$C_{i,i}^v$	Virtual concentration of i at interface M/L
C_V	Orifice coefficient
d	Vertical distance to y, L
d_B	Bubble diameter, L
d_o	Orifice diameter, L
D	Diameter, L
DF	Decontamination factor, dimensionless
D_L	Liquid diffusivity, L^2/s
D_p	Particle diameter, L
E	Vapor/entrained solid, M/M, modulus of elasticity, F/L^2
f	Friction factor
f_d	Temperature derating factor
f_f	Fitting adjustment factor
F_d	Drag force
g	Gravity acceleration, L/t^2
g_c	Gravitational conversion, ML/F/t^2

G	Mass velocity on surface $L^3/L^2/t$
h	Enthalpy, FL/mol
H	Henry's Law constant, FL/mol
HDB	Hydrostatic design basis
H_{sat}	Saturation humidity, M/M dry air
I	Moment of inertia, L^4
k	Heat capacity ratio
k_D	Liquid-solid partition coefficient, L^3/M
k_g	Gas phase mass transfer coefficient, L^2mol/F/t
k_L	Liquid phase mass transfer coefficient, L/t
k_s	Solid phase mass transfer coefficient, $M/L^2/t$
K_i	Various overall liquid mass transfer coefficients, L/t, Kelvin
K_La	Overall liquid mass transfer coefficient, t^{-1}
K_o	Constant part of K_La
L	Length, L, Inductance, psi-s^2/in^3 (note, specialized unit for process control)
L^{-1}	Inverse Laplace transform
M	Mass, M
Ma	Mach number, dimensionless
$M_{x,y}$	X and y moments
MW	Molecular weight, M/mol
n	Number
N_A	Mass transfer flux of component A
p_i	Partial pressure of i, F/L^2
P	Pressure, F/L^2
q	Concentration on GAC, M/M
Q	Gas flow rate, L^3/t

r	Radius, L
r_i	Rate, unit/t
R	Resistance, psi-s/in^3 (note, specialized unit for process control)
R_b	Bending radius
Re_G	Reynolds number, gas, dimensionless
Re_o	Orifice Reynolds number
R_g	Gas constant, FL/mol/T
RH	Relative humidity
R_p	Critical pressure ratio
s	Laplace transform variable
S_i	Arc length, L
Sc	Schmidt number, dimensionless
Sh	Sherwood number, dimensionless
t	Time, t
T_g	Gas temperature
v_G	Superficial tank velocity, L/t
v_o	Orifice velocity, L/t
v_s	Slip velocity, L/t
v_t	Terminal velocity, L/t
V_L	Volume liquid, L^3
V_{sl}	Sludge volume, L^3
w	Gas mass flow rate, M/t, weight, M
x	Horizontal distance, L
X_i	Concentration of i in solid, M/M
y	Height, L, gas concentration, mol/mol
Z	Compressibility factor

Greek

Δ	Change in quantity
ε	error, efficiency, roughness
θ	Segment angle, radians
Λ	Stripping factor, MF/L^2/mol
μ	Viscosity, M/L/t
ρ_L	Liquid density, M/ L^3
ρ_s	Sludge density, M/ L^3
ρ_g	Gas density, M/ L^3
φ	Gas holdup
Φ	Heavyside step function
σ	Surface tension, F/L
τ	Residence time, t, various time constants
ω	Mass transfer rate, mol/t

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TANK V-14 AIR STRIPPING CALCULATIONS AND PROCESS SIZING

1. PURPOSE

1.1 Background

The PM-2A Tanks site Technical Support Facility (TSF-26) consisted of two carbon steel, abandoned, 189,270-L (50,000-gal) underground storage tanks (USTs), ancillary equipment, and the contaminated soil around them. The total waste currently in these tanks is approximately 43,000 kg (94,800 lb). The tanks currently are located at the Idaho CERCLA Disposal Facility (ICDF) (tank V-13 is in the ICDF disposal cell and V-14 is in an ICDF east storage pit waiting treatment).

The tanks were installed in the mid-1950s and stored concentrated low-level liquid radioactive waste from the Test Area North (TAN) Intermediate-Level Radioactive Waste Management System from 1955 to 1981. The tanks currently contain sludge contaminated with radionuclides, heavy metals, and organic compounds. Although the tanks were partially filled with diatomaceous earth to absorb free liquid in 1981, small quantities of free liquids may be present in the tanks.

Phase I of the PM-2A tanks remediation consisted of excavating soil to obtain access to the tanks; performing necessary inspections on the tanks; isolating, capping, removing, and disposing any ancillary equipment; removing the tanks from their current location; transporting the tanks to the TAN-607A High Bay for storage; performing confirmation sampling of the cradle sand; and backfilling and closing the PM-2A site (i.e., TSF-26). Since there was no evidence of a release from the tanks, the cradles and cradle sand were removed and disposed.

Phase II of the PM-2A tanks remediation consists of sampling and treating the tank contents as necessary; packaging and transporting the tanks and tank contents to the ICDF disposal facility; disposing of the tanks and tank contents at the ICDF, and disposing any secondary waste generated during treatment at the ICDF or other approved disposal facility (e.g., GAC).

1.2 Scope

The overall project scope is to provide a treatment system to remove tetrachloroethylene (PCE) from tank V-14 by air sparging, i.e., the treatment system for Phase II above. No other Phase I or II activities are addressed in this Engineering Design File (EDF). The specific scope of this EDF is to provide process design input for the treatment system. This process design includes the following:

- Determine appropriate mass transfer constants from laboratory testing
- Scale up laboratory results to full size system (in-tank treatment) using appropriate correlations
- Determine the air flow needed to remove the PCE in 4 weeks or less in a liquid based system (Wendt 2005), i.e., by adding 1000 gal of water to V-14
- Provide sizing for the granular activated carbon (GAC) adsorption system and efficiency
- Provide mechanical design information for a layout and equipment list
- Provide a flowsheet for the process.

2. SAFETY CATEGORY

Consumer Grade

3. NATURAL HAZARDS PHENOMENA PERFORMANCE CATEGORY

N/A

4. SUBJECT-SPECIFIC DATA

4.1 Summary Laboratory Report

Three experiments were conducted: one bubbling air through the as-received solid and two bubbling air through the wet solids (Pao 2005[a]). The EXCEL spreadsheets of laboratory data are included in Appendix B, laboratory data. The calculations including modeling and scaleup from laboratory data are in Appendix C. Analysis of the data, both dry and wet, seems to indicate diffusion control through the solid. Ordinarily, the mass transfer coefficient would be a constant for air stripping liquids with dissolved volatile organic compounds (VOCs). However, the data suggests it is a function of time to some power (e.g., $K \alpha t^n$).[b] Since there is some theoretical justification (Bird, et al.; Treybal), the power of -½ was selected. The results of the data from the better of the two wet tests, along with model results are shown in Figure 1.[c] The model uses the conservative method of first and last points as shown (see Appendix C).

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a. Initially, the laboratory was instructed to perform air sparging on the actual waste as-received (damp solid). After an initial test, the project decided to investigate "wet-sparging" as a treatment alternative. This modification was based on two factors:

- The desire to avoid a drying of the sludge particulates that would trigger contamination concerns (see Section 4.2, bullet 1)
- The treatment train called for follow-up solidification – thus water would eventually be needed. In this way, water is added up-front.
- Previous design studies for air sparging of slurries to remove VOCs had already been performed for treatment of the consolidated V-tank waste (Tanks V1, V2, V3, V9, and other wastes). This previous study could be used, in part, as a basis for treatment of the contents of Tank V-14, especially if the contents were made into a slurry form.

b. This type of data suggests a possible diffusion controlled mechanism from solids

c. The one not used was difficult to assess because the air flow rate was varied whereas in the second one, the air flow was constant.

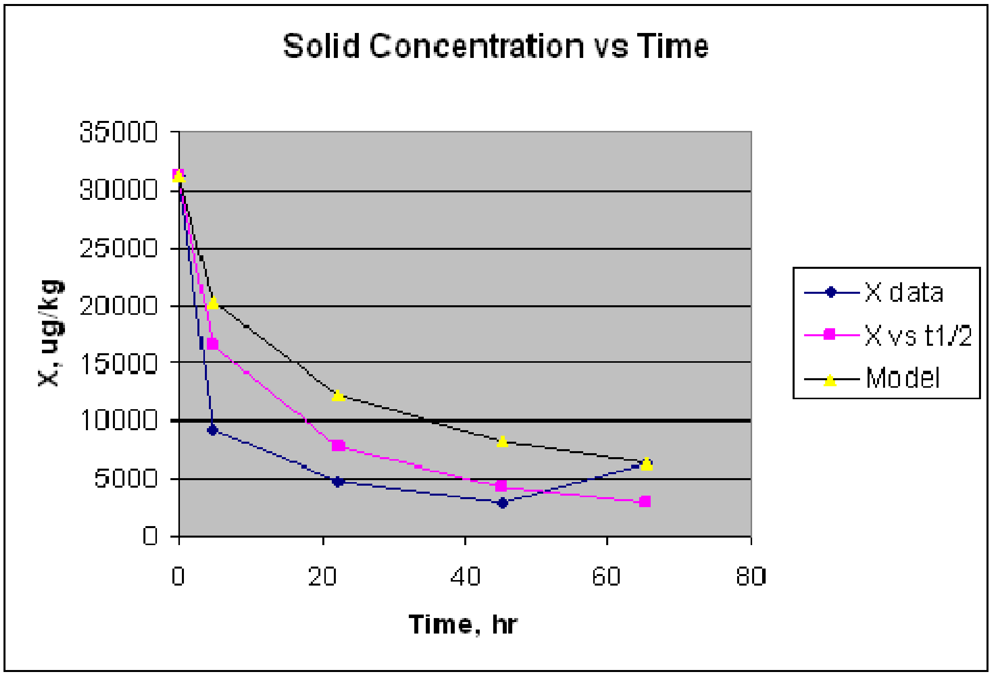

Figure 1. Laboratory and Model Results.

4.2 Summary Mock-Up

Mock-up testing was conducted to determine a nozzle configuration with good air distribution and mixing and for adding solidification agent (Anderson 2005). Based on the mock-up testing, there will be 10 nozzles; one in each end and two per ribbed section.[d] The flow total rate is 2,000 scfm, 200 scfm/nozzle. A schematic of the nozzle is shown in Figure 2. Each nozzle has a total of eight orifices as shown.[e]

d. Tank V-14 has 5 internal ribbing that divide the tank into 6 sections.

e. The additional 2 orifices shown 60° apart are post mock-up additions.

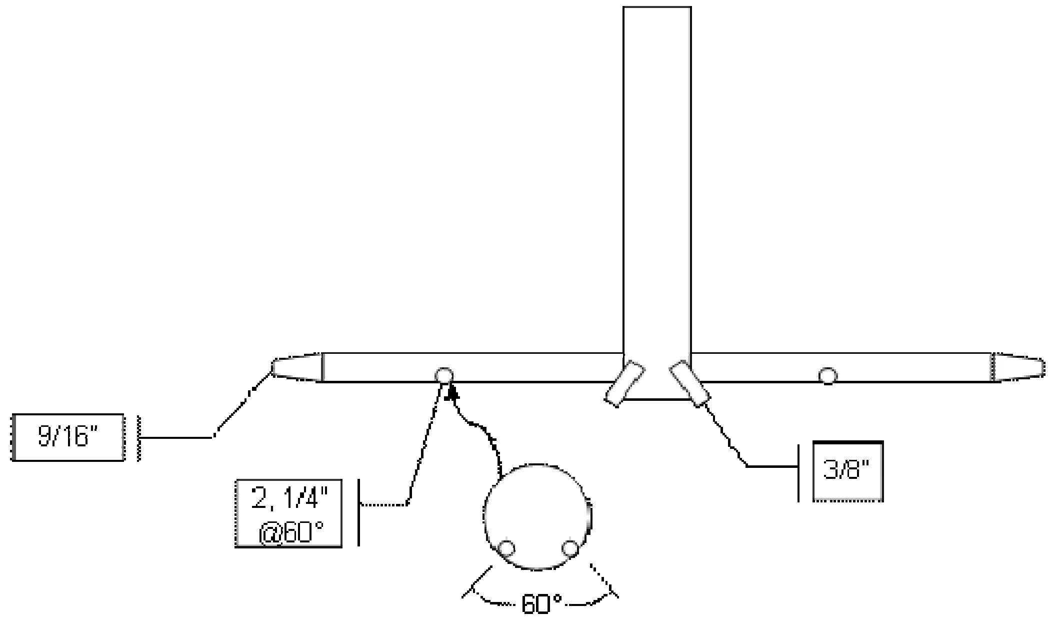

Figure 2. Mockup Nozzle Configuration

4.3 Project Direction

The following direction was provided by the Project Engineer (Wendt 2004):

- Water (raw) will be added to the tank system to help keep down particle entrainment in the off-gas system. This will also help mix the system via air jet and fluid velocities.
- Critical instrumentation includes a meter to monitor relative humidity so it does not drop below 90%.
- Gas emissions will meet worker protection, i.e., industrial hygiene.
- Total PCE emissions will be reduced in the off-gas by 95% in comparison to uncontrolled emission level as specified in 40 CFR 264 Subpart AA.[f]
- The treatment time to meet standards is 4 weeks.
- HEPA filters require a relative humidity of 90% or less (RH ≤ 90%).

4.4 Previous Work

Previous work has been accomplished on the V-Tank project for air stripping via sparge involving tanks V-1, -2, -3, and -9 (Ashworth 2004). Much of the material used for those tanks is applicable to this project. Also, many of the references apply. There are some differences however in the V-14 system,

f. The APAD demonstrated compliance with 40 CFR 61.92, 93 and 94 even with uncontrolled emissions. Therefore there is no additional project direction for off gas control design based upon these regulations.

since there will be no agitation so the correlations are different. The mass transfer constants are found by laboratory data where in the previous project, they were determined by theory and published correlations. The scale-up for this project involves using the Sherwood number (Sh) that is a dimensionless number used in mass transfer.[g] Also, the laboratory testing for the stripping data had no mixing so a distinction should be made. What is really desired for stripping is areal contact coverage, i.e., the ideal would be for the air to flow up through a column of sludge to get geometric similarity with the laboratory. Since there are geometric differences between the V-14 tank and the laboratory, mixing to ensure this is desired. This was done during the mockup testing that demonstrated good mixing.

4.5 Results

4.5.1 PCE Removal Rate

The laboratory data was scaled up using the Sherwood number for gas bubbling through liquid and the semi-empirical relationship for the mass transfer coefficient as a function of time. This information is provided in Appendix C. The scale-up requirement was to remove the PCE from 108 mg/kg to 6 mg/kg in 28 days. Based on the scale up and the mass transfer coefficient, the results for solid and gas phase are shown in Figure 3 for an air flow rate of 200 scfm.[h] Much shorter time to achieve the criteria is predicted by using the flow recommended based on mock-up results, i.e., < one day as shown in Figure 4. Also, this flow was compared to mixing empirical data (Perry et al. 1984) and it is shown in Appendix C that complete mixing can be achieved if the solution is sufficiently fluidic with appropriate sparge air distribution.[i]

---

g. Sometimes called the Nusselt number for mass transfer

h. This 200 is the minimum total flow, not the flow per nozzle.

i. The 28 days was the criterion established as a design basis. Therefore, the system minimum flow was estimated for 28 days. The air flow required to do this was much less but in Rev. 0, 1,000 scfm was recommended due to uncertainties and the requirement to obtain adequate mixing not just sparging Later, the mockup testing results recommended 2,000 scfm to achieve the mixing. 2,000 scfm was evaluated in the scaleup model and the result was 8 hours of required sparging. A similar timeframe would have been calculated with 1,000 scfm if tried. The real time to complete sparging likely exceeds 8 hrs as there will never be perfect suspension, mixing, and mass transfer per the ideal conditions assumed for the scaleup. However, this should be a good order of magnitude estimate. Either way 8 hours or 80 hours is acceptable.

The reduction in required GAC is a result of the isotherm. Since the calculation predicts less treatment time, the average concentration in the off gas must be much higher. The average concentration was calculated by the total amount over the total volume of air during that time. The isotherm at that greater concentration provides a much greater capacity for absorbance. As PCE concentration increases in the off gas, the capacity of the GAC to absorb it efficiently also increases thereby requiring less GAC overall. In either case, the GAC required is less than the amount specified for the design. Each carbon bed holds approximately 400 lbs of carbon. So each bed holds roughly ten times the total carbon calculated to be required. If treatment were to take 28 days, each gac bed still holds 2.5 times the total carbon required.

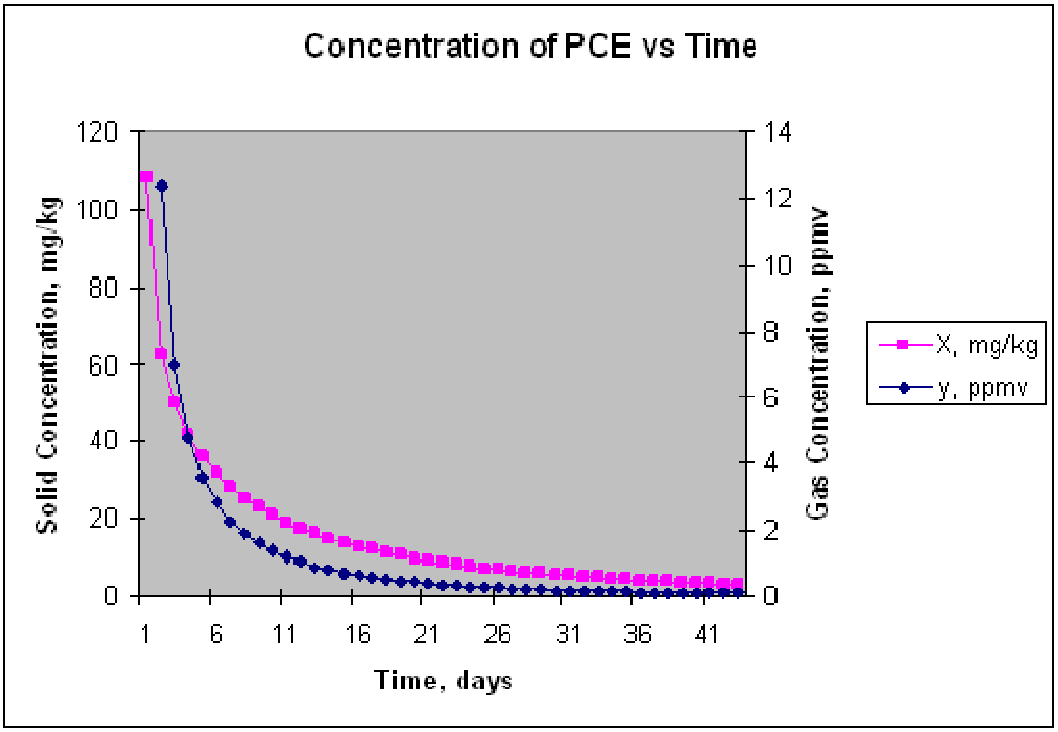

Figure 3. PCE Removal vs. Time based on Sherwood scale-up.

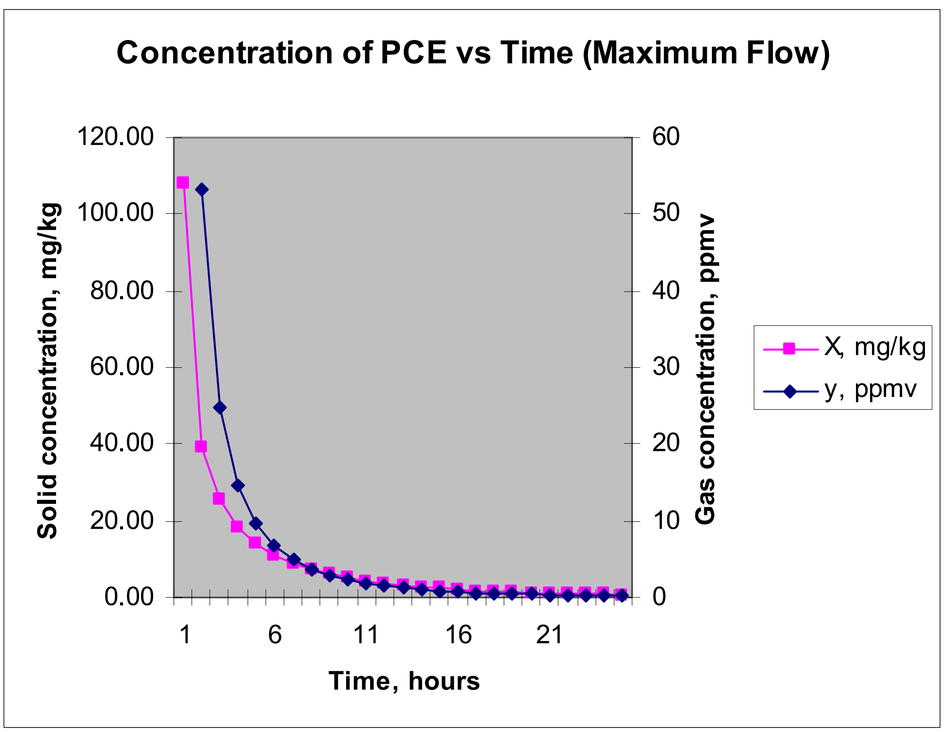

Figure 4. PCE Removal vs. Time based on 2,000 scfm.

4.5.2 Equipment Size Information

Using the total sparge flowrate of 2,000 scfm, standard sizes for filters, fans, and GAC can be used which simplifies the design and procurement. This information and selected equipment is provided in Appendix C and briefly discussed below.

- GAC consists of two TIGG N-1000 radial units or equivalent based on flow, the minimum carbon required for the isotherm is exceeded by a large margin.
- Electric gas heaters approximately 11 kW each.
- A compressor rated at 220 acfm at 100 psig. The compressible flow procedure indicates this meets requirement for 2,000 scfm
- The 12-ft stack is stable with 425-lb weight added.
- Sizing based on the flowsheet per Figure 5.

4.5.3 Flowsheet

The process schematic/flowsheet is provided in Figure 5. The fan is started up on bleed air until the compressor is ramped up. Air pressure is controlled to provide the appropriate flow and tank pressure as discussed in Appendix C. Air dryers remove moisture from the compression. The air is bubbled through the solution via nozzles/orifices that mix and strip PCE. The off-gas first contacts a mist eliminator or demister where aerosols are removed down to about 5µm. The gas phase is then heated, filtered via a HEPA, re-heated, and fed through GAC prior to being transferred out to the atmosphere via a stack.[j] As discussed in Appendix C, the air flows were modeled to match laboratory data and also compared to empirical knowledge for mixing.

5. ASSUMPTIONS

- Mixing/distribution during sparging will be as effective as the laboratory/mockup system
- The Sherwood number scaleup is appropriate for this system
- Other assumptions as stated within.

6. ACCEPTANCE CRITERIA

Tank V-14 is considered treated when the PCE concentration is <6 mg/kg based on total concentration, i.e., meet the land disposal restriction (LDR) per the Technical and Functional Requirements TFR-234 (INEEL 2004) from 108 mg/kg at the 90% UCL in four weeks. There will be no free liquid remaining. This may be accomplished by continuing the air sparge until dry or adding a solidification agent. The environmental discharge must have off-gas process units (i.e., GAC) capable of 95%-efficient VOC removal in the off-gas (INEEL 2004) and those concentrations needed to meet industrial hygiene limits (Ashworth 2004) as shown in Table 1.

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[j] The decreases in humidity are not requirements but a result of the 10°F increase in temperature. The basis for the isotherm is 100°F at 80 %RH

Table 1. Industrial Hygiene Limits for PCE.

	TWA-TLV	IDLH	15-minute STEL	Ceiling
PCE	25 ppm	150 ppm	100 ppm	200 ppm

The off-gas release from the sparge system will need to comply with 40 CFR 264.1032(a). The regulation is presented in this EDF:

40 CFR 264.1032 Standards: Process vents

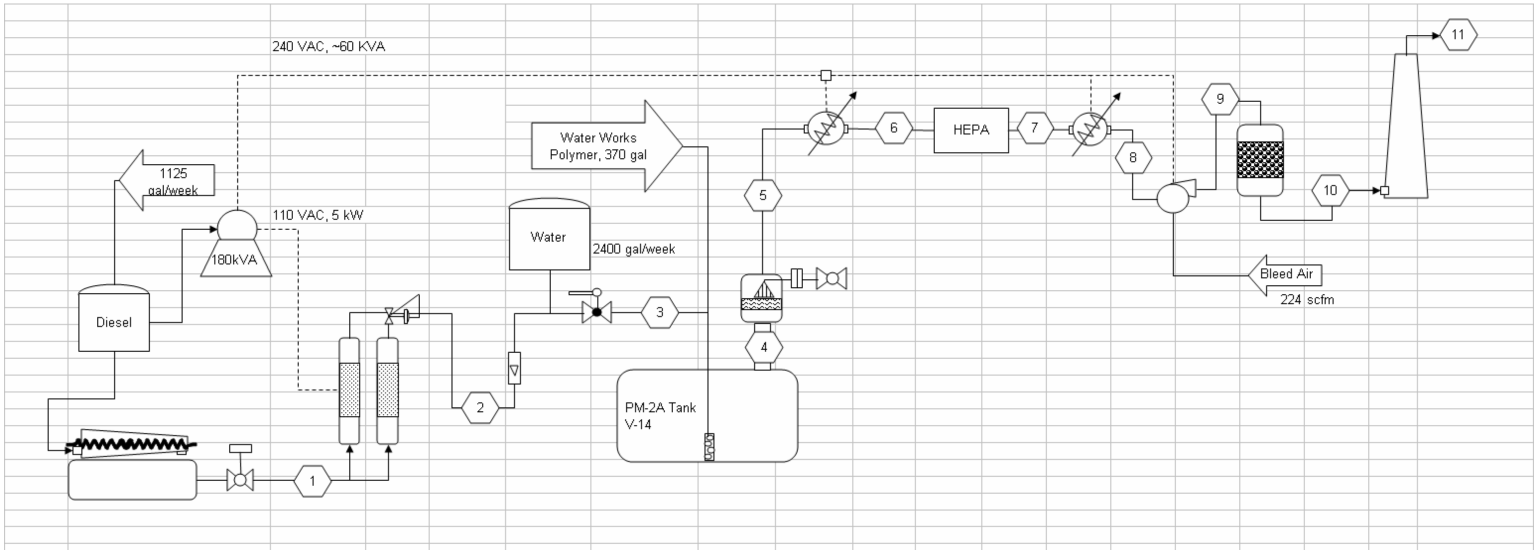
(a) The owner or operator of a facility with process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction or air or steam stripping operations managing hazardous wastes with organic concentrations at least 10 ppmw shall either:

(1) Reduce total organic emissions from all affected process vents at the facility below 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 tons/yr), or

(2) Reduce, by use of a control device, total organic emissions from all affected process vents at the facility by 95 weight percent.

As a batch process, the PCE will vary with time. Therefore, (2) above is demonstrated in Appendix C, II, GAC and configuration.

Other TFR (INEEL 2004) process design related requirements considered relevant to process design are in the T&FR matrix for meeting criteria shown in Table 2.



Material & Energy Balance											
Stream	1	2	3	4	5	6	7	8	9	10	11
	Compressed Air	Dry Air	Sparge Air	Exit Sparge Air	Mist Eliminator	Heater 1 Outlet	HEPA Outlet	Heater 2 Outlet	Fan Outlet	GAC Outlet	Stack Outlet
P, psig/in H_2O	100.00	20.00	8.00	-0.50	-1.52	-2.56	-4.56	-4.97	6.65	2.85	0.00
T, °F	70.00	70.00	70.00	70.00	70.00	80.00	80.00	90.00	90.00	90.00	90.00
Flow, scfm	2000.00	2000.00	200.00	2000.00	2000.00	2000.00	2000.00	2000.00	2224.00	1112.00	2224.00
Flow, acfm	222.22	769.23	121.95	1997.12	1991.29	2022.79	1973.99	2008.25	2309.49	1121.23	2224.00
Rate, lb/min	161.56	161.56	16.16	161.56	161.56	161.56	161.56	161.56	179.65	89.83	179.65
RH, %	100.00	0.00	0.00	100.00	100.00	70.00	70.00	50.00	50.00	50.00	50.00
VOCs											
Naphthalene, ppt_v	0.00	0.00	0.00	0.32	0.32	0.32	0.32	0.32	0.29	2.86E-03	2.86E-03
PCE, ppm_v	0.00	0.00	0.00	13.94	13.94	13.94	13.94	13.94	12.54	1.25E-01	1.25E-01
TCE, ppt_v	0.00	0.00	0.00	2.62	2.62	2.62	2.62	2.62	2.36	2.36E-02	0.02
xylenes, ppt_v	0.00	0.00	0.00	0.55	0.55	0.55	0.55	0.55	0.49	4.93E-03	0.00
SVOCs, ppt_v											
Aroclor-1260	0	0	0	1.70E-01	3.41E-03	3.41E-03	4.20E-05	4.20E-05	3.77E-05	1.71E-05	1.71E-05
Fused Ring	0	0	0	6.11E-01	1.27E-02	1.27E-02	5.72E-04	5.72E-04	5.15E-04	6.56E-05	6.56E-05
Phenols	0	0	0	1.06E-01	2.13E-03	2.13E-03	3.71E-05	3.71E-05	3.34E-05	1.07E-05	1.07E-05
Phthalates	0	0	0	1.42E-01	2.90E-03	2.90E-03	9.50E-05	9.50E-05	8.54E-05	1.48E-05	1.48E-05
Radionuclides, pCi/L											
Actinides	0	0	0	5.88E-01	1.18E-02	1.18E-02	1.18E-04	1.18E-04	1.06E-04	5.29E-05	5.29E-05
^{63}Ni	0	0	0	4.68E+01	9.37E-01	9.37E-01	9.37E-03	9.37E-03	8.42E-03	4.21E-03	4.21E-03
^{90}Sr	0	0	0	2.37E+02	4.75E+00	4.75E+00	4.75E-02	4.75E-02	4.27E-02	2.13E-02	2.13E-02
^{137}Cs	0	0	0	2.84E+02	5.69E+00	5.69E+00	5.69E-02	5.69E-02	5.12E-02	2.56E-02	2.56E-02

Figure 5. Process flowsheet/material balance (note, stream 3 is split out into ten streams).

Table 2. Technical and Functional Requirements Matrix.

Requirement	Design to Meet
3.1.2.8-2 The treatment system shall be designed to treat all necessary hazardous constituents in the PM-2A tanks waste to ensure conformance to the LDRs and disposal facility WAC.	The design is based on removing PCE by air sparging.
3.1.2.8-3 The treatment system shall be designed to handle material with a consistency range from a very wet paste to a dry solidified sludge/diatomaceous earth contaminated with radionuclides, organic compounds (including chlorinated solvents), and inorganic contaminants (including metals), with essentially no free liquids.	Sparge tube pressure designed for density of sludge expected ≈ 1.5 kg/L. Water (1000 gal) will be added per project direction (Wendt 2005). According to flowsheet, will likely need 2400 gal.
3.1.2.8-6 The design shall ensure that containment of potential off-gas (e.g., VOCs or particulate radionuclides) is maintained during treatment of the tank contents, if treated.	Most of system designed under vacuum. Radionuclides removed via HEPA, VOCs removed via GAC.
3.1.2.8-8 The treatment system shall provide a means to monitor necessary treatment and off-gas parameters to ensure performance of the treatment process (e.g., to determine when treatment has been completed).	There are 2 ports for portable or permanent analyzers upstream and down from the GAC, and an off-gas flowmeter.
3.1.2.8-9 Off-gas and containment systems shall ensure radionuclide and toxic emissions to the on-site worker, environment and community are within acceptable limits (10 mrem/yr for the off-Site receptor) as defined by 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities."	This EDF does not evaluate this. The design includes a HEPA system to prevent radionuclides from being emitted and will meet worker protection per project direction (Wendt 2005).
3.1.2.8-12 The treatment system shall be designed to ensure that treatment process lines and components will not plug. Note: The possibility of choke flow must be evaluated and mitigated to ensure functionality.	Design can only provide sizing based on scaleup from the laboratory. The only lines that can plug are the sparge tubes. Pluggage would depend on operations. The pressure calculations were trial and error with the requirement that the Mach number is less than one ($Ma < 1$). Evaluated in Appendix.

Requirement	Design to Meet
3.2.7-1 The project shall control releases of hazardous and radioactive effluents to the environment within the limits referenced in DOE Order 5400.5, "Radiation Protection of the Public and the Environment" and the National Contingency Plan (NCP).	Meet worker protection per project direction (Wendt 2005). Provide HEPA and GAC for radioactive and hazardous components.
3.2.7-2 The project shall maintain releases of radioactive materials to the environment and community within acceptable limits as defined by 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities."	Meet worker protection per project direction (Wendt 2005). Provide HEPA filtration for radionuclides.
3.2.7-4 The release of carcinogenic and noncarcinogenic contaminants into the air shall be estimated before start of construction, controlled, if necessary, and monitored during soil excavation, waste removal, treatment, if performed, and decontamination activities.	Process design provides a flowsheet for treatment.
3.2.7-5 The project shall limit exposure to 1 mrem/yr for the off-Site receptor, as a result of radioactive contamination releases from the project and establish monitoring and compliance requirements.	No radionuclide exposure evaluation in this EDF (Wendt 2005).
3.2.7-10 The project shall provide a filtration capability, as necessary, designed to ensure that filter integrity is maintained, on the tanks and treatment system to ensure no VOCs or particulate radionuclides are released to the environment.	Provide HEPA and GAC for radioactive and hazardous components to ensure negligible VOCs and radionuclides in the effluent. Pressure differential monitoring to ensure filtration capability and filter integrity.
3.4.1-4 The project shall provide mockups of critical treatment equipment and process design to validate system design and performance.	Mockup results from sparge testing included.

7. SOFTWARE

The following industry-wide software, requiring no validation, was used for this EDF:

- Mathcad Version 11
- EXCEL Version 2003.

8. CALCULATIONS

See Appendix C.

9. CONCLUSIONS

Although the laboratory data has some precision issues, the overall trend is suggested by time-related function. The concentration decreases with time. The model conservatively provides a mass transfer coefficient to model this. There are uncertainties with scaleup, particularly the geometries of the two systems being so different.

10. RECOMMENDATIONS

The nominal sparger design flow of 2,000 scfm is recommended. This provides the design basis for most of the system. It is also recommended to use the radial flow GAC unit shown in Appendix C.

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APPENDIX A - Task Planning Documentation

The task planning document is covered in the Work Agreement (Work Agreement 2005).

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APPENDIX B - Laboratory Data

Table B1. Raw Data.

V-14 AS Test Summary

Batch #1	**INTEC Lab Sample**		AS-1			
Date	Sample ID	Description	PCE (ppb)		Mass (g)	
12/8/2004	AS 1-0	Homo. Initial	48000		10	
		Total Initial			126	
		AS 21.5 hrs			93	
12/9/2004	AS-1-1		92		5	
	AS-1-1-1		280		1	
	AS-1-1-2		14		1	
	AS-1-1-3		96		1	
		Net		120.5	85	
12/9/2004		**AS 96 hrs**			53	
12/13/2004	As 1-2		18		8	
	AS 1-2-2		10		1	
	AS 1-2-2		5		1	
	AS 1-2-3		13		1	
		Net		11.5	42	
Batch #2-1	**BWXT Return Samples**		AS-2			
	ID	Description	PCE (ppb)			
12/23/2004	AS-2-0	Homo. Initial	25000		13	
	AS 2-0-1				1	
	AS 2-0-2				1	
	AS 2-0-3				1	
	BWXT(503 g)+H2O(250 g)			650 ml	753	
1/3/2005	AS 2-1-1L	liquid*	28	supernate	7	*note: mixture settled 11 days prior sampling
	AS 2-1-2L	liquid-homo	24		7	
	AS 2-1-1S	wet sludge	72350	wet sludge	7	

	AS 2-1-2S	sludge-homo	46980		7	
		total			725	
		AS 25.8 hrs		2~5.5 L/min	671	
1/4/2005	AS-2-2L	top-liq.**	32	~400 ml	6	**Note: mixture settled 1 hrs prior sampling
	AS-2-2S	bottom sludge	244	~150 ml	6	
		net			659	
		wash water			8	
		total			667	
		AS 22.7 hrs		2~5.5 L/min	622	
1/5/2005	AS-2-3L	upper layer**	427	similar viscosity	6	
	AS-2-3S	bottom sludge	1750	& physical like	6	
		net			610	
		wash water			10	
		total			620	
		AS 21.3 hrs		2 L/min	579	
1/6/2005	AS-2-4-1S	upper layer**	1076	suspended material	6	
	AS-2-4-2S	bottom sludge	115	compacted material	6	
		net			567	
	add 250 ml water					
		total			817	
		AS 95.2 hrs		2 L/min	527	
1/10/2005	AS-2-5-1S	upper layer**	111		6	
	AS-2-5-2S	bottom sludge	542		6	
		net		~300 ml	515	
	add water 138 ml					
		total			653	
Batch #2-2	**BWXT Return Samples**		AS-3			
	ID	Description	PCE (ppb)			
1/19/2005	AS-3-0	Homo. Ini.	41000		10	

1/24/2005	BWXT(439g)+H2O(220 g)			570 ml	659
1/24/2005	AS-3-1L	upper layer**	57188		6
	AS-3-1S	bottom sludge	31210		6
		total ini.			647
		AS 4.7 hrs		2 L/min	632
1/24/2005	AS-3-2L	upper layer**	311		6
	AS-3-2S	bottom sludge	9362		6
		net			620
		AS 17.5 hrs		2 L/min	586
1/25/2005	AS-3-3L	upper layer**	28		6
	AS-3-3S	bottom sludge	4868		6
		net			574
	Add wash water 18 ml				
		total			592
		AS 23 hrs		2 L/min	547
1/26/2005	AS-3-4L	upper layer**	38		6
	AS-3-4S	bottom sludge	2852		6
		net			535
	add wash water 10ml				
		total			545
		AS 20 hrs		2 L/min	509
1/27/2005	AS-3-5L	upper layer**	44		6
	AS-3-5S	bottom sludge	6325		6
		net			497

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APPENDIX C - Calculations for Air Stripping and Process Design

Index

I. Determine from the laboratory data the mass transfer coefficient

I.a Theory.

The overall coefficient has all the individual coefficients For brevity, this is (Ashworth 2004):

$$K_L \cdot a = \frac{1}{\frac{1}{k_D \cdot k_s \cdot a_s} + \frac{1}{k_L \cdot a_L} + \frac{1}{H \cdot k_g \cdot a_g}}$$

Note, a liquid coefficient

The scaleup is based on the liquid Sh (Treybal 1987) with Re_G based on the slip velocity correlated by:

$$Sh_L = \frac{K_L \cdot d_B}{c \cdot D_L} = a + b \cdot Re_G{}^c \cdot Sc_L{}^d \cdot \left(\frac{d_B \cdot g^f}{D_L{}^h} \right)^j$$

Where:

$a := 2$

$b := 0.0187$

$c := 0.779$

$d := 0.546$

$f := \frac{1}{3}$

$h := \frac{2}{3}$

$j := 0.116$

Since K_L is proportional to the Sh and assuming the function is >> a in the above Sh:

$$K_{L2} \cdot d_{B2} = K_{L1} \cdot d_{B1} \cdot \left(\frac{Re_{G2}}{Re_{G1}}\right)^c \cdot \left(\frac{d_{B2}}{d_{B1}}\right)^j \qquad \text{or} \qquad K_{L2} = K_{L1} \cdot \left(\frac{Re_{G2}}{Re_{G1}}\right)^c \cdot \left(\frac{d_{B2}}{d_{B1}}\right)^{j-1}$$

Note: the above K_L is uncoupled with specific surface area as defined in Treybal. There will be many changes of subscripts to track this throughout with notes provided as explanation.

Since The slip velocity (v_s) is:

$$a_i = \frac{6 \cdot \phi_i}{d_{Bi}} \qquad v_s = \frac{v_G}{\phi_G} \qquad \phi_G = \frac{v_G}{v_s}$$

Note: ϕ is the gas holdup

The Reynolds number based on slip velocity is:

$$Re_G = \frac{d_B \cdot v_s \cdot \rho_L}{\mu_L}$$

The bubble size, d_B, depends on the orifice Re, for Re_o =10000 to 50000 in orifice range 0.4 to 1.6 mm (Treybal):

$$d_B = 0.0071 \cdot Re_o^{-0.05}$$

The diffusion coefficient D_L is for the PCE-water system (using 1.6 x 10^{-9} for air). This used later to show the Sh ratios can be used without consideration of the constant a.

$$D_L := 1.6 \cdot 10^{-9} \frac{m^2}{s} \cdot \sqrt{\frac{29}{133}} \qquad D_L = 7.471 \times 10^{-10} \frac{m^2}{s}$$

I.b Model for air stripping V-14 wet solids based on data:

Since the overall coefficient is based on liquid, the liquid driving force is used:

In terms of flux at any time:

Note: Coupled $K_L a$

$$N_A = -K_L \cdot \left(C_{As}{}^{v} - C_{Av}{}^{v} \right)$$

$$C_{As}{}^{v} = \frac{X_A}{k_D} \qquad C_{AV}{}^{v} = \frac{p_A}{H_A}$$

In terms of the rate of change:

$$\frac{d}{dt} C_{As}{}^{v} = -K_L \cdot a \cdot \left(\frac{X_A}{k_D} - \frac{p_A}{H_A} \right)$$

Multiplying both sides by k_D:

$$\frac{d}{dt} X_A = -K_L \cdot a \cdot \left(X_A - \frac{p_A \cdot k_D}{H_A} \right)$$

This rest has been previously derived (Ashworth 2004):

$$\ln\left(\frac{X_f}{X_i} \right) = -K_L \cdot a \cdot \left(1 - \Lambda \cdot \frac{k_D}{H} \right) t \qquad \Lambda = \frac{P \cdot H \cdot K_L \cdot a \cdot M}{\omega_s \cdot H + K_L \cdot a \cdot M \cdot k_D \cdot P}$$

$$K_L \cdot a = \frac{-1}{t} \cdot \ln\left(\frac{X_f}{X_i} \right)$$

Note: $K_L a$ is what is found by experiment

The measured $K_L a$ is actually:

$$K_L \cdot a = K_L \cdot a \cdot \left(1 - \Lambda \cdot \frac{k_D}{H} \right)$$

I.c Laboratory Results, wet

I.c.1 Bench Scale Stripping

$$lbmol := 454 mol \qquad R_g := 10.73 \frac{lbf \cdot ft^3}{lbmol \cdot R \cdot in^2} \qquad MW_{air} := 29 \frac{lb}{lbmol}$$

$$\rho_s := 1.5 \frac{kg}{L} \qquad Q_{Lab} := 2 \frac{L}{min} \qquad t_{Lab} := 65.2\ hr$$

$$P_{atm} := 12.5 psi \qquad T_g := 298\ K$$

It was found using the lab data that the $K_L a$ is a function of time, i.e.:

$$K_L \cdot a = \frac{K_o}{t^n}$$

The best fit was for n = 1/5. However, n = 1/2 was fairly good and there is a theoretical basis from penetration mass transfer theory (Treybal 1987, Bird et al 1960). Therefore, it is recommended that the first and last data points are used with this correlation to be conservative. The last data point upward curvature appears to be a signature of the system related to sampling error (Pao 2005).

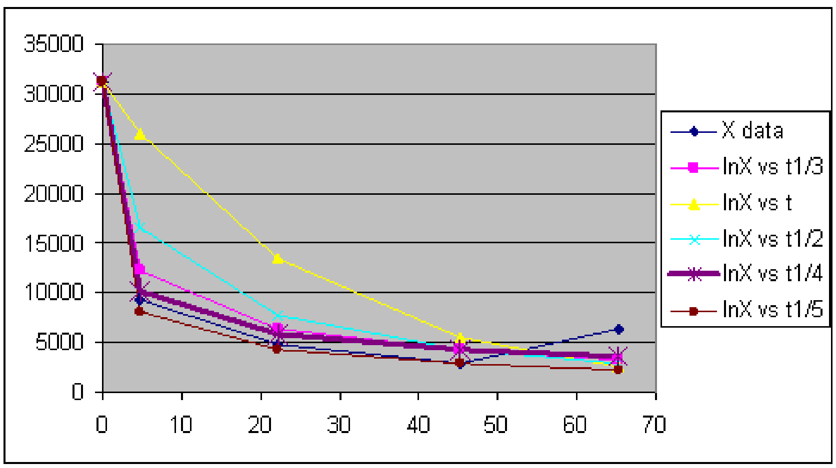


Figure C-1. Laboratory data curve fit.

$$\frac{d}{dt}X = \frac{-K_o}{\sqrt{t}} \cdot X \cdot \left(1 - \Lambda \cdot \frac{k_D}{H}\right) \qquad \ln\left(\frac{X_f}{X_i}\right) = -K_o \cdot \int \frac{1}{\sqrt{t}}\, dt \qquad \ln\left(\frac{X_f}{X_i}\right) = -2 \cdot K_o \cdot t^{\frac{1}{2}}$$

$$K_o = \frac{-1}{\sqrt{t}} \cdot \ln\left(\frac{X_f}{X_i}\right)$$

Note: This the constant part of the $K_L a$

From the data

$$X_f := 6.325 \frac{mg}{kg} \qquad X_i := 31.21 \frac{mg}{kg}$$

$x_{Lab} := 1 - \frac{X_f}{X_i}$ $x_{Lab} = 0.797$ In terms of extent

Note: constant part of K_La from lab, λ designates lab.

$K_{oLa\lambda} := \frac{-1}{\sqrt{t_{Lab}}} \cdot \ln\left(\frac{X_f}{X_i}\right)$ $K_{oLa\lambda} = 0.003 \frac{1}{s^{0.5}}$ $K_{oLa\lambda} = 0.198 \frac{1}{hr^{0.5}}$

Need to define a working Reynolds number (Re) as the mass transfer is related to it and it is related to Q. For flow through the test column air bubbling uses the slip Re (Treybal 1987):

$Re_G = \frac{d_B \cdot v_s \cdot \rho_L}{\mu_L}$ $Re_o = \frac{d_o \cdot v_o \cdot \rho_g}{\mu_g}$ $\rho_L := 1 \frac{kg}{L}$

$\mu_g := 1.2 \cdot 10^{-5} \frac{lb}{ft \cdot s}$ $\rho_g := \frac{P_{atm} \cdot MW_{air}}{R_g \cdot T_g}$ $D_{Lab} := 3in$

$n_o := 16$ $d_o := \frac{1}{16} in$ $v_o := \frac{4 \cdot Q_{Lab}}{n_o \pi \cdot d_o^2}$

$V_{Lab} := 570mL$ $y_{Lab} := \frac{4 \cdot V_{Lab}}{\pi \cdot D_{Lab}^2}$ $y_{Lab} = 4.921in$

$Re_o := \frac{d_o \cdot v_o \cdot \rho_g}{\mu_g}$ $Re_o = 94.398$ $g_c := 9.8 \frac{kg \cdot m}{kgf \cdot s^2}$

$\sigma := 73 \frac{dyne}{cm}$ $v_G := \frac{4 \cdot Q_{Lab}}{\pi \cdot D_{Lab}^2}$ $v_G = 0.007 \frac{m}{s}$

Find a correlation between v_G and v_s by plotting v_G/v_s vs v_G for larger diameter tank using the lower data where this operation lies (Treybal 1987 Figure 6.2)

$vx := \begin{pmatrix} 0 \\ 0.003 \\ 0.01 \\ 0.02 \\ 0.04 \end{pmatrix}$ $vy := \begin{pmatrix} 0 \\ 0.01 \\ 0.028 \\ 0.05 \\ 0.09 \end{pmatrix}$ $vg := \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$ Note, these are MathCad vectors for curve fitting

$$\mathrm{pwrfit}(vx, vy, vg) = \begin{pmatrix} 1.366\times 10^{0} \\ 8.451\times 10^{-1} \\ -1.39\times 10^{-5} \end{pmatrix} \qquad y(v_G) = \alpha\cdot v_G{}^{\beta} + \gamma$$

where

$$y(v_g) = \frac{v_G}{v_s} \qquad \beta := 0.845 \qquad \alpha := 1.366\left(\frac{s}{m}\right)^{\beta} \qquad \gamma := -1.39\cdot 10^{-5}$$

$$\frac{v_G}{v_s} = \alpha\cdot v_G{}^{\beta} + \gamma \qquad v_s := \frac{v_G}{\left(\alpha\cdot v_G{}^{\beta} + \gamma\right)} \qquad v_s = 0.342\frac{m}{s}$$

$$\phi_\lambda := \frac{v_G}{v_s} \qquad \phi_\lambda = 0.021$$

Note, γ is small enough to ignore when calculating v_G from v_s, i.e.:

$$v_G{}^{1-\beta} = \alpha\cdot v_s \qquad v_G = \left(\alpha\cdot v_s\right)^{\frac{1}{1-\beta}}$$

$$d_B := 0.0071\cdot m\cdot Re_o{}^{-0.05} \qquad d_B = 0.006\ m \qquad \mu_L := .01poise$$

Since $Re_o < 2100$, use a different correlation (Treybal 1987)

$$d_B := 0.0287m^{\frac{1}{2}}\cdot d_o{}^{\frac{1}{2}}\cdot Re_o{}^{\frac{1}{3}} \qquad d_B = 0.005m \qquad d_B = 5.207\ mm$$

$$a_\lambda := \frac{6\cdot\phi_\lambda}{d_B} \qquad a_\lambda = 24.633\frac{m^2}{m^3}$$

$$K_{oL\lambda} := \frac{K_{oLa\lambda}}{a_\lambda} \qquad K_{oL\lambda} = 1.338\times 10^{-4}\frac{m}{s^{0.5}}$$

Note: The uncoupled K_L from the lab

$$Re_G := \frac{d_B\cdot v_s\cdot \rho_L}{\mu_L} \qquad Re_G = 1780.354$$

$$Sc_L := \frac{\mu_L}{D_L \cdot \rho_L} \qquad Sc_L = 1338.464$$

$$Sh_L := a + b \cdot Re_G^{\,c} \cdot Sc_L^{\,d} \cdot \left(\frac{d_B \cdot g^f}{D_L^{\,h}} \right)^j \qquad Sh_L = 980.057$$

Justifying assumption of "a" small compared to function

I.c.2 Nozzle Mockup Testing

The sparge nozzle system below was mocked up. The recommendation is to use 10 of these units at 200 scfm each, 2000 scfm.

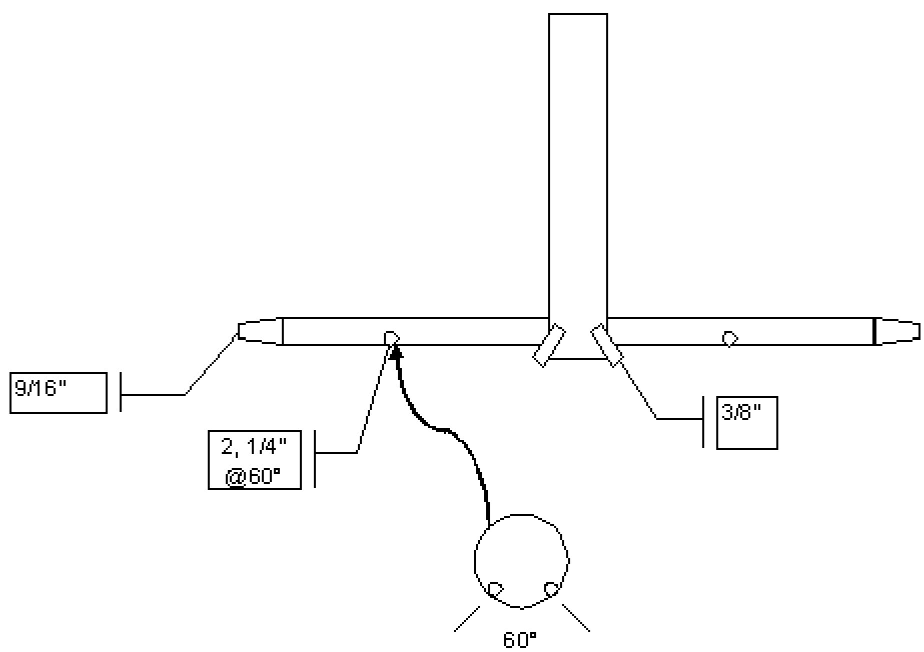


Figure C-2. Nozzle configuration.

I.d Scaleup to V14, wet

Tank dimensions

$D_{tk} := 12.5ft$ $\qquad$ $L_{tk} := 55ft$

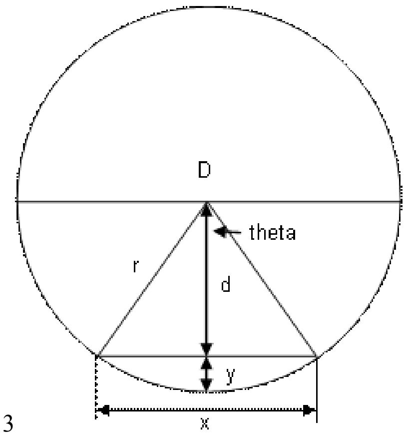


Figure C-3. Tank geometry.

Need to find θ, x, and y

$$r := \frac{D_{tk}}{2}$$

$$V_{tk} := \frac{\pi}{4} \cdot D_{tk}^{2} \cdot L_{tk} \qquad V_{tk} = 6749.515 \ ft^3$$

$$M_{tk} := 46030 \ lb$$

$$\rho_s := 1.5 \frac{kg}{L} \qquad A_{tk} := \frac{\pi}{4} \cdot D_{tk}^2 \qquad A_{tk} = 122.718 \ ft^2$$ Area for ends

$$V_{sl} := \frac{M_{tk}}{\rho_s} \qquad V_{sl} = 491.553 \ ft^3$$ Volume of sludge

$$A_{seg} := \frac{V_{sl}}{V_{tk}} \cdot A_{tk} \qquad A_{seg} = 8.937 \ ft^2$$ By volume ratio

$$\theta - \sin(\theta) = \frac{2 \cdot A_{seg}}{r^2} \qquad \frac{2 \cdot A_{seg}}{r^2} = 0.458$$

Trial and error for θ since transcendental

First guess:

$$\theta := \frac{2 \cdot A_{seg}}{r^2} \qquad \theta = 0.458 rad \qquad \sin(\theta) = 0.442 \qquad \theta - \sin(\theta) = 0.016$$

2nd guess:

$$\theta := 1.45 rad \qquad \sin(\theta) = 0.993 \ rad \qquad \theta - \sin(\theta) = 0.457$$

$$S_i := r \cdot \theta \qquad S_i = 9.063 \ ft \qquad C_i := 2 \cdot \pi \cdot r \qquad C_i = 39.27 \ ft$$

$x := 2 \cdot r \cdot \sin\left(\frac{\theta}{2}\right)$ $\qquad x = 8.289 \text{ ft}$

$d := \frac{1}{2} \cdot x \cdot \cot\left(\frac{\theta}{2}\right)$ $\qquad d = 4.678 \text{ ft}$ $\qquad y := r - d$ $\qquad y = 1.572 \text{ ft}$

Find centroids for average x,y

$A_{seg} = \int_0^y x\,dy$ $\qquad A_{seg} := \int_0^y 2 \cdot \sqrt{r^2 - (r-y)^2}\,dy$ $\qquad A_{seg} = 8.931\text{ft}^2$

$M_y := \int_0^y y \cdot \left[2 \cdot \sqrt{r^2 - (r-y)^2}\right] dy$ $\qquad M_y = 8.358 \text{ ft}^3$ $\qquad$ y moment

$M_x := \int_0^y 4 \cdot \left[r^2 - (r-y)^2\right] dy$ $\qquad M_x = 56.592 \text{ ft}^3$ $\qquad$ x moment

$y_{ave} := \frac{M_y}{A_{seg}}$ $\qquad y_{ave} = 0.936 \text{ ft}$ $\qquad$ y centroid

$x_{ave} := \frac{M_x}{A_{seg}}$ $\qquad x_{ave} = 6.336 \text{ ft}$ $\qquad$ x centroid

$A_{ave} := x_{ave} \cdot L_{tk}$ $\qquad A_{ave} = 348.494 \text{ ft}^2$ $\qquad$ Longitudinal normal to flow at centroid

Match Re (Re_G). Since the orifices are different sizes, will use a weighted, numerical average size:

orifice diameter $\qquad$ number of orifices

Let

$d_{o2} := \frac{\frac{1}{4}\text{in} \cdot 2 + \frac{3}{8}\text{in} + \frac{9}{16}\text{in}}{4}$ $\qquad n := 10 \cdot 8$ $\qquad d_{o2} = 0.359 \text{ in}$

Initial and final required concentration

$X_i := 108 \frac{mg}{kg}$ $X_f := 6 \frac{mg}{kg}$

Find minimum flow rate using 4 weeks: $t_m := 4 \cdot 7 \cdot day$ $t_m = 672 \; hr$

$K_{oLam} := \frac{-1}{\sqrt{t_m}} \cdot \ln\left(\frac{X_f}{X_i}\right)$ $K_{oLam} = 0.002 \frac{1}{s^{0.5}}$

Note: The constant part of the K_La for the upper actual, i.e. 2 weeks

$K_{L2} = K_{L1} \cdot \left(\frac{Re_{G2}}{Re_{G1}}\right)^c \cdot \left(\frac{d_{B2}}{d_{B1}}\right)^{j-1}$

$Re_{G2} = Re_{G1} \cdot \left[\frac{K_{L2}}{K_{L1}} \cdot \left(\frac{d_{B2}}{d_{B1}}\right)^{1-j}\right]^{\frac{1}{c}}$

To find the gas flow, the procedure is as follows:
1. guess a_2, d_{B2} (Note, a double trial and error procedure. However, it's not as difficult as it seems since d_B changes little with Re_o. Hence the major trial variable is a_i)
2. calculate the holdup
3. calculate the uncoupled K_L
4. calculate the gas Re based on lab scaleup
5. calculate the the slip velocity
6. calculate the superficial gas velocity based on the correlation
7. calculate the flowrate based on gas velocity and centroid area
8. calculate the orifice Re
9. calculate bubble diameter based on orifice Re
10. calculate gas velocity based on slip velocity and holdup
11. compare bubble size and specific area and adjust to convergence

$a_2 := 15 \frac{m^2}{m^3}$ $d_{B2} := 4.458 \, mm$

Note: the uncoupled constant part of K_La for the upper range of the actual

$\phi_2 := \frac{a_2 \cdot d_{B2}}{6}$ $\phi_2 = 1.1145 \times 10^{-2}$ $K_{oLm} := \frac{K_{oLam}}{a_2}$

$$Re_{G2} := Re_G \cdot \left(\frac{K_{oLm}}{K_{oL\lambda}}\right)^{\frac{1}{c}} \cdot \left(\frac{d_{B2}}{d_B}\right)^{\frac{1-j}{c}} \qquad Re_{G2} = 1352.979$$

$$v_{s2} := \frac{Re_{G2} \cdot \mu_L}{\rho_L \cdot d_{B2}} \qquad v_{s2} = 0.303 \frac{m}{s}$$

$$v_{G2} := \left(\alpha \cdot v_{s2}\right)^{\frac{1}{1-\beta}} \qquad v_{G2} = 3.399 \times 10^{-3} \frac{m}{s}$$

$$Q_{Sh} := v_{G2} \cdot A_{ave} \qquad Q_{Sh} = 233.159 \frac{ft^3}{min}$$

$$Re_o := \frac{4 \cdot Q_{Sh} \cdot \rho_g}{n\pi \cdot d_{o2} \cdot \mu_g} \qquad Re_o = 10839.102$$

Check bubble size and ϕ, iterate as required to get match

$$d_{B2} := 0.0071\,m \cdot Re_o^{-0.05} \qquad d_{B2} = 4.462\ mm$$

$$\phi := \frac{v_{G2}}{v_{s2}} \qquad \phi = 1.11988 \times 10^{-2} \qquad \text{OK}$$

$$w_{Sh} := Q_{Sh} \cdot \rho_g \qquad w_{Sh} = 14.685 \frac{lb}{min}$$

The minimum flow to meet 4 weeks is Q_{Sh}.

However, the mockup recommended 200 scfm/nozzle. Therefore:

$$Q_n := 2000 \frac{ft^3}{min} \qquad w_n := Q_n \cdot \rho_g \qquad w_n = 125.965 \frac{lb}{min}$$

Another check is by degree of agitation. Perry's (Perry's 1984) provides values for moderate, complete and violent agitation as shown below for 9-and 3-ft height.

Table C-1. Degree of agitation.

	Air Rate	Air Rate
Degree of Agitation	cfm/ft^2, 9 ft	cfm/ft^2, 3 ft
Moderate	0.65	1.3
Complete	1.3	2.6
Violent	3.1	6.2

For the 2000 scfm flow:

$$G_{tk} := \frac{Q_n}{x \cdot L_{tk}} \qquad G_{tk} = 4.387 \frac{ft^3}{ft^2 \cdot min}$$

Therefore, it is expected to be completely mixed especially since the full area is used in the above instead of the centroid.

Predict time required to meet criteria for the 2000 scfm.

$$v_{G2} := \frac{Q_n}{L_{tk} \cdot x_{ave}} \qquad v_{G2} = 0.096 \frac{ft}{s}$$

$$v_{s2} := \frac{v_{G2}}{\left(\alpha \cdot v_{G2}^{\beta} + \gamma\right)} \qquad v_{s2} = 1.389 \frac{ft}{s}$$

$$\phi_2 := \frac{v_{G2}}{v_{s2}} \qquad \phi_2 = 0.069$$

$$Re_o := \frac{4 \cdot Q_n \cdot \rho_g}{n\pi \cdot d_{o2} \cdot \mu_g} \qquad Re_o = 9.298 \times 10^4$$

$$d_{B2} := 0.0071\,m \cdot Re_o^{-0.05} \qquad d_{B2} = 0.004\ m$$

$$Re_{G2} := \frac{d_{B2} \cdot v_{s2} \cdot \rho_L}{\mu_L} \qquad Re_{G2} = 1696.909$$

$$K_{oL2} := K_{oL\lambda} \cdot \left(\frac{Re_{G2}}{Re_G}\right)^c \cdot \left(\frac{d_{B2}}{d_B}\right)^{j-1} \qquad K_{oL2} = 1.624 \times 10^{-4} \frac{m}{s^{0.5}}$$

$$a_2 := \frac{\phi_2 \cdot 6}{d_{B2}} \qquad a_2 = 103.084 \frac{m^2}{m^3}$$

$$K_{oLa2} := K_{oL2} \cdot a_2 \qquad K_{oLa2} = 0.017 \frac{1}{s^{0.5}}$$

$$t_{Pred} := \left(\frac{-1}{K_{oLa2}} \cdot \ln\left(\frac{X_f}{X_i}\right)\right)^2 \qquad t_{Pred} = 8.28 \text{ hr}$$

I.d Estimation of solid and gas phase PCE concentration vs. time.

For the Minimum flow (Sh subscript):

$$X(t) = X_i \cdot e^{-K_{oLam} \cdot \sqrt{t}}$$

$$\Lambda = \frac{P \cdot H \cdot K_{Lam} \cdot M}{\omega_s \cdot H + K_{Lam} \cdot M \cdot k_D \cdot P}$$

or if $\omega_s H >> K_L a M k_D P$

$$\Lambda = \frac{P \cdot H \cdot K_{Lam} \cdot M}{\omega_s \cdot H} \qquad H_{PCE} := 16.95 \frac{L \cdot atm}{mol}$$

$$p = \Lambda X = \Lambda \cdot X_i \cdot e^{-K_{oLam} \cdot \sqrt{t}} \qquad \omega_s := \frac{w_{Sh}}{MW_{air}} \qquad \omega_s = 3.832 \frac{mol}{s}$$

$$\Lambda = \frac{P_{atm} \cdot K_{oLam} \cdot M_{tk}}{\omega_s \cdot \sqrt{t}} \qquad K_{oLam} = 1.858 \times 10^{-3} \frac{1}{s^{0.5}}$$

The gas and solid concentrations are shown below where p is simply found by multiplying X by Λ (and using the time in $K_L a$).

Similar expressions are used for the maximum flow with:

$K_{oLa2} = 0.017 \frac{1}{s^{0.5}}$ and $\omega_n := \frac{w_n}{MW_{air}}$ $\qquad \omega_n = 32.867 \frac{mol}{s}$

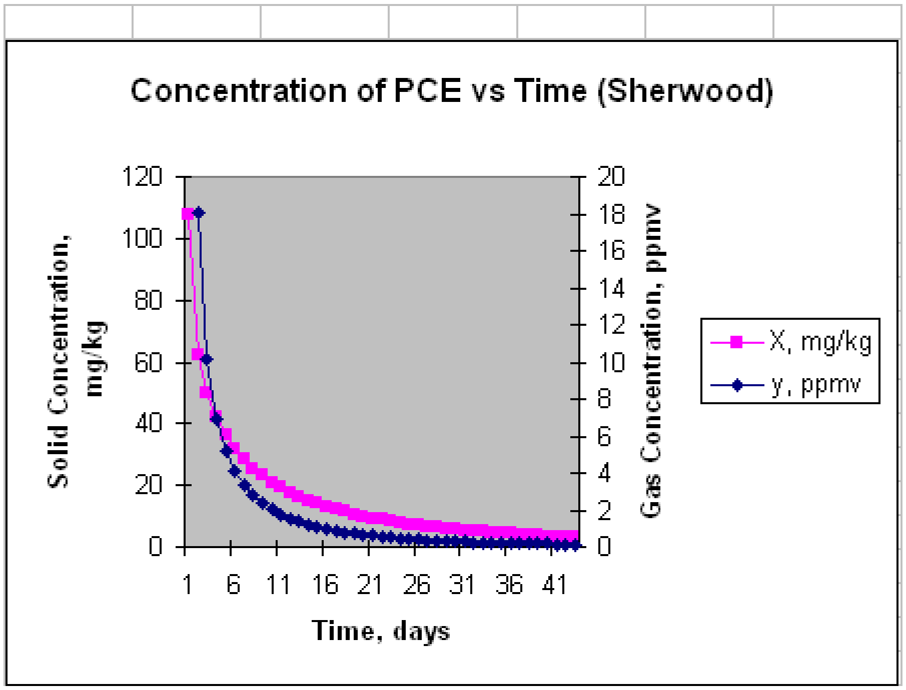


Figure C-4. Concentration vs. Time, minimum flow.

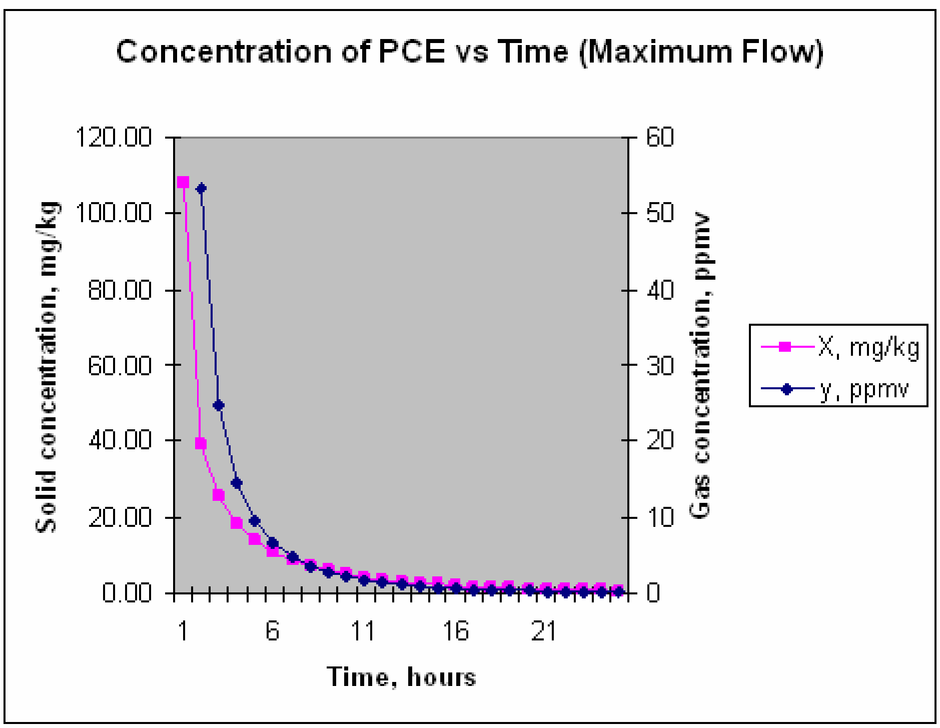


Figure C-5. Concentration vs. Time, 2000 scfm.

Note, for zero sparge flow, the Λ reduces to the equilibrium value of:

$\Lambda = \frac{H}{k_D}$ A relation similarly found in the literature for wet solids (Valsaraj 1995).

II. Determine the GAC required and configuration

Determine the GAC unit size for the PCE removal.

Use a nominal temperature of 70°F although for the GAC isotherm use 100°F.

$T_{g1} := (460 + 70) \cdot R$ $T_{g2} := (460 + 80) \cdot R$

$RH_1 := 100\ \%$ Increase the temperature by 10°F

$RH_2 := 70\%$ By psychrometric chart (Perry's 1984)

Need concentration in the gas phase:

Average based on 8 hours: $ppm_v := \frac{L}{L} \cdot 10^{-6}$ $MW_{PCE} := 131.5 \frac{gm}{mol}$

Mass of PCE in tank

$w_{PCE} := M_{tk} \cdot X_i$ $w_{PCE} = 2.255\,kg$

$y_{PCEave} := \frac{w_{PCE} \cdot 22.4 \frac{L}{mol}}{Q_n \cdot MW_{PCE} \cdot t_{Pred}}$ $y_{PCEave} = 13.651\ ppm_v$

From TIGG data, the isotherm can be derived in equation form for PCE. Using 80%RH and 100°F:

TIGG Isotherm data, PCE 80%RH at 100°F

$$y_{ppmv} := \begin{pmatrix} 0.1 \\ 1 \\ 10 \\ 100 \\ 1000 \\ 10000 \end{pmatrix} \qquad q := \begin{pmatrix} 2 \\ 4 \\ 7.2 \\ 16 \\ 27 \\ 42 \end{pmatrix} \qquad vx := \begin{pmatrix} 2 \\ 4 \\ 7.2 \\ 16 \\ 27 \\ 42 \end{pmatrix} \qquad vy := \begin{pmatrix} 0.1 \\ 1 \\ 10 \\ 100 \\ 1000 \\ 10000 \end{pmatrix}$$

$$vg := \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$$

Note: vectors for powerfit correlation

$$\mathrm{pwrfit}(vx, vy, vg) = \begin{pmatrix} 3.297\times 10^{-5} \\ 5.225\times 10^{0} \\ 1.055\times 10^{1} \end{pmatrix} \qquad a := 3.297\cdot 10^{-5} \qquad b := 5.22\text{:} \qquad c := 10.5\text{:}$$

$$q(y) := \frac{a\cdot y^{b} + c}{100} \qquad q\left(y_{PCEave}\right) = 10.55\frac{gm}{100gm}$$

$$w_{GAC} := \frac{w_{PCE}}{q\left(y_{PCEave}\right)} \qquad w_{GAC} = 47.121lb$$

Therefore design by flow needing a minimum of 47 lb GAC. It would be practical to minimize unused GAC while accommodating the required flow at reasonable ΔP. This is suggested by using the TIGG radial flow or equivalent as shown below for the N-1000 for 1000 scfm (2 in parallel).

Note: the DF assigned for the flowsheet is 100, > than the required of 95% (DF = 20). The following are DF/efficiency conversions.

$$DF = \frac{w_i}{w_o} = \frac{1}{1 - \%} \qquad DF_{95\%} := \frac{1}{1 - 0.95} \qquad DF_{95\%} = 20$$

The efficiency of the GAC is > 95%. The design for GAC in air service for PCE (and most other VOCs) is in fact zero otherwise the facemask canisters used by the Army could allow in nerve gas. This can be seen by the dynamic breakthrough plots (Miyake et al 2003, Huang et al 2003, Sullivan et al 2005). This, in general, is true of all adsorbates/adsorbents given enough time for an equilibrium zone and mass transfer zone (MTZ) to develop and that the length parallel to the flow is > MTZ. The reason a DF of 100 (99%) was chosen is that in practice, there is a small amount of leakage conservatively assigned. This is not the same thing as making an assumption.

In the GAC system design, the length >> MTZ and the GAC mass >> isotherm mass. The residence time >> than previous design by Flanders Filters for the V-Tank project. Also, various sources indicate 95 - 98% (EPA 1999). While this EPA document was for 500 ppm_V inlet, observation of the 3rd breakthrough curve (below) shows no difference for C/C_O for any of the concentrations. Tests at the JPL show that the removal is at least 95% even at low concentrations less than the V-14 average influent value (Foster-Wheeler 2001). While it is true that not all VOCs will behave accordingly, PCE has a particularly good affinity for activated carbon with an excellent isotherm. GAC is the best available technology for low concentrations of PCE present in the V-14 project off-gas.

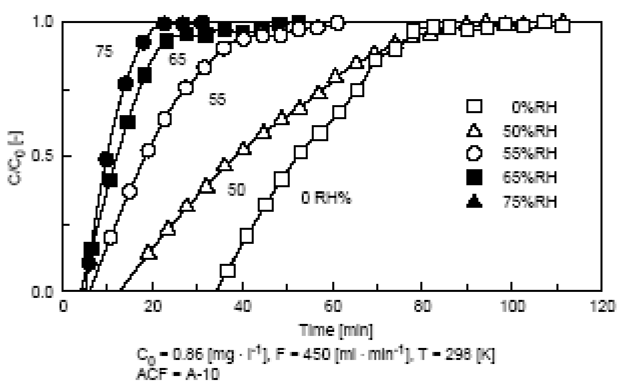


Figure C-6. TCE breakthrough.

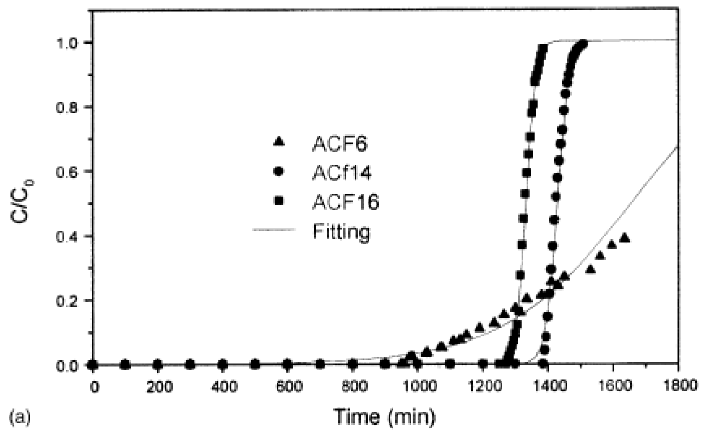


Figure C-7. Breakthrough, Actual vs. a Typical Fit.

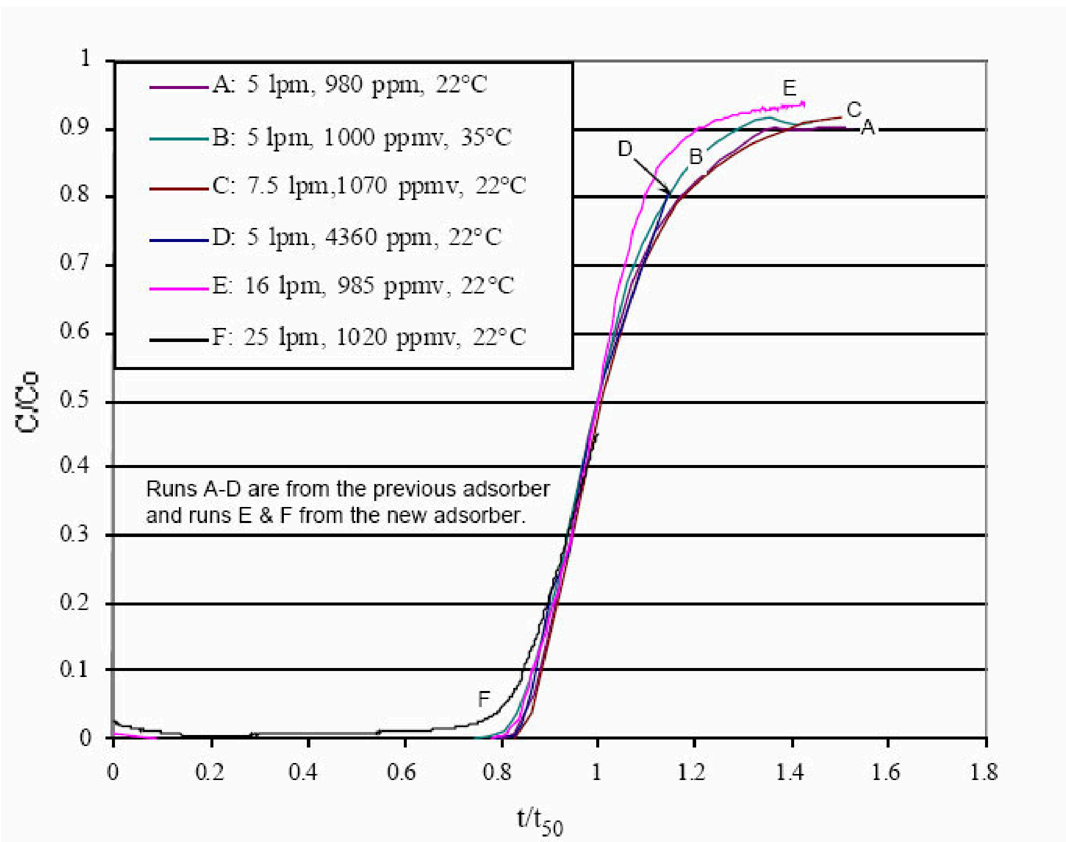


Figure C-8. Breakthrough, Differing Concentrations

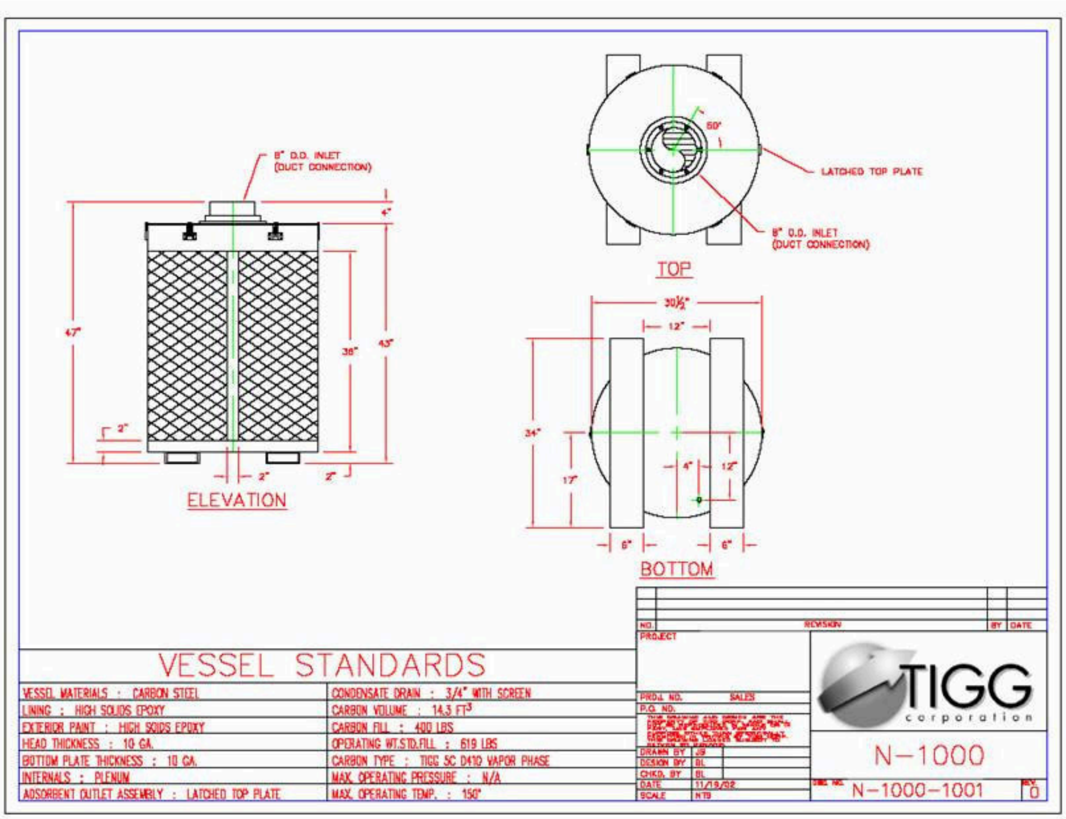


Figure C-9. GAC Specification Sheet

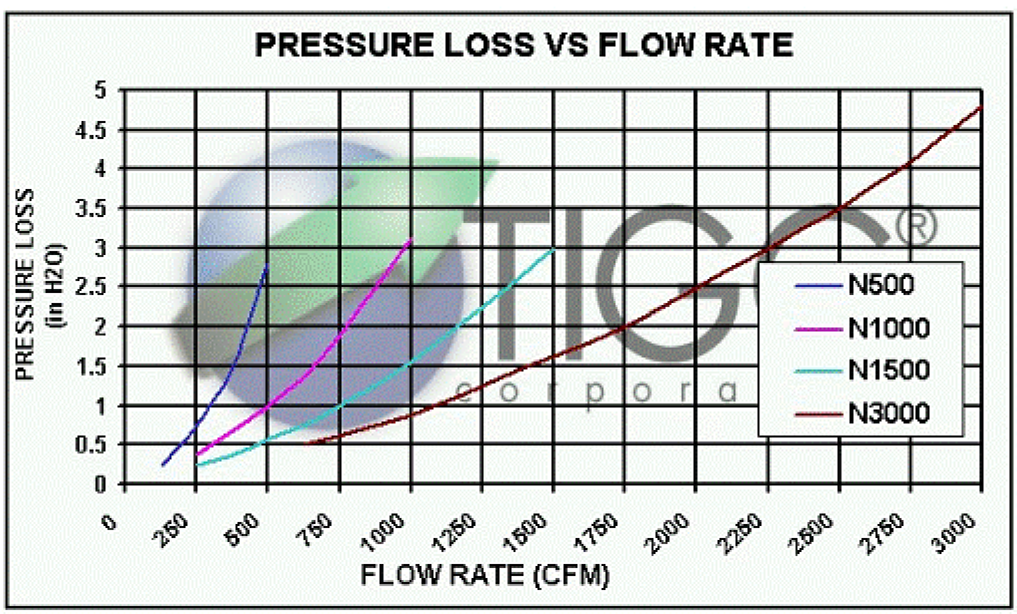


Figure C-10. GAC Pressure Drop vs. Flow

III. Determine heater power

Use an overdesign of 20°F.

heater 1 from 70°F to 90°F $\qquad T_{h1} := 550\,R$

heater 2 from 90°F to 110°F $\qquad T_{h2} := 570\,R$

$a := 6.386 \dfrac{cal}{mol \cdot K}$ $\qquad b := 1.762 \cdot 10^{-3} \dfrac{cal}{mol \cdot K^2}$ $\qquad c := -0.2656 \cdot 10^{-6} \dfrac{cal}{mol \cdot K^3}$

$c_{pair}(T) := a + b \cdot T + c \cdot T^2$ $\qquad MW_{air} := 29 \dfrac{gm}{mol}$ $\qquad$ (Hougen et al 1958)

Heater 1

$$\Delta h_{htr1} := \int_{T_{g1}}^{T_{h1}} \frac{w_n}{MW_{air}} \cdot c_{pair}(T)\, dT \qquad \Delta h_{htr1} = 10.526\ kW$$

Heater 2

$$\Delta h_{htr2} := \int_{T_{h1}}^{T_{h2}} \frac{w_n}{MW_{air}} \cdot c_{pair}(T)\, dT \qquad \Delta h_{htr2} = 10.553\ kW$$

IV. Pressure losses for compressor sizing

Determine pressure and flow downstream of compressor at pressure reducing valve (PRV)

Air heat capacity ratio

$k := 1.4$ $\qquad g_c := 9.8 \dfrac{kg \cdot m}{kgf \cdot s^2}$ $\qquad MW_{air} := 29 \dfrac{gm}{mol}$

$P_{atm} := 12.5\,psi$ $\qquad lbmol := 454\,mol$ $\qquad T_g := 530\ R$

Speed of sound. Note, cannot exceed Mach number of 1 some refer to as choked flow:

$c := \sqrt{\dfrac{k \cdot R_g \cdot T_g}{MW_{air}}}$ $\qquad c = 1127.306\ \dfrac{ft}{s}$ $\qquad Ma = \dfrac{v}{c}$

Assume the compressor has a rating of 250 acfm at 100 psig. $P_1 := 100 psi$

This is a compressible flow trial & error procedure by finding average density in each part. The nominal flow (Q_n) is determined from the scaleup. The (PRV) pressure is guessed until the pressure in the tank is near atmospheric and the Mach number (Ma) is less than one.

Validate flow through PRV assuming a high recovery valve:

$C_1 := 18.4$ $\qquad C_g := 4680 \dfrac{ft^3 \cdot R^{0.5}}{hr \cdot psi}$

http://www.fisherregulators.com/technical/sizingcalculations/#SizingforGasorSteamService

Guess P_2 $\qquad P_2 := 21 psi$

$$\rho_2 := \frac{(P_2 + P_{atm}) \cdot MW_{air}}{R_g \cdot T_g} \qquad \rho_2 = 0.171 \frac{lb}{ft^3}$$

$$\Delta P_{PRV} := P_1 - P_2 \qquad \Delta P_{PRV} = 79 psi$$

$$Q := \sqrt{\frac{520}{T_g}} \cdot C_g \cdot P_1 \cdot \sin\left[\left(\frac{59.64}{C_1} \cdot \frac{\Delta P_{PRV}}{P_1}\right) \cdot rad\right] \qquad Q = 4240.285 \frac{ft^3}{min}$$

$\rho_{ave} := \dfrac{\rho_2 + \rho_g}{2}$ $\qquad f_f := 1.5$ $\qquad$ A factor for additional pressure losses

$\rho_{ave} = 0.117 \dfrac{lb}{ft^3}$ $\qquad$ average density through complete system

$\mu_g := 1.2 \cdot 10^{-5} \dfrac{lb}{ft \cdot s}$ $\qquad Q_r := \dfrac{w_n}{\rho_2}$ $\qquad Q_r = 736.703 \dfrac{ft^3}{min}$

$$Z(P_{ave}) := 1.101 \times 10^{-8} \cdot \frac{1}{psi^2} \cdot (P_{ave})^2 - 2.286 \times 10^{-5} \cdot \frac{1}{psi} \cdot P_{ave} + 1$$

Compressibility factor determined from Perry's data (Perry et al 1984)

Guess ρ_{ave}, find Q, calc ΔP, calc ρ_{ave}:

Compressor to solenoid (neglect dryer ΔP), designate as 3 for 3 inch:

$P_2 - P_3 = \Delta P_3$ $\quad$ $P_3 = P_2 - \Delta P_3$ $\quad$ $D_3 := 3in$ $\quad$ $L_3 := 16\,ft$

$\rho_{ave3} := 0.168\dfrac{lb}{ft^3}$ $\quad$ $Q_3 := \dfrac{w_n}{\rho_{ave3}}$ $\quad$ $Q_3 = 749.791\ \dfrac{ft^3}{min}$

$Re_3 := \dfrac{4 \cdot Q_3 \cdot \rho_{ave3}}{\pi \cdot D_3 \cdot \mu_g}$ $\quad$ $Re_3 = 8.91 \times 10^5$

$f_3 := \dfrac{0.04}{Re_3^{0.16}}$ $\quad$ For rough estimates, use f for turbulent (Perry et al 1984)

$\Delta P_3 := \dfrac{32 \cdot f_3 \cdot \rho_{ave} \cdot L_3 \cdot Q_3^{\,2} \cdot f_f}{\pi^2 \cdot D_3^{\,5} \cdot g_c}$ $\quad$ $\Delta P_3 = 1.405\ psi$ $\quad$ $P_{ave} = \dfrac{P_2 + P_3}{2}$

$P_{ave_2} := \dfrac{2P_2 - \Delta P_3}{2} + P_{atm}$ $\quad$ $\rho_{ave3} := \dfrac{P_{ave_2} \cdot MW_{air}}{R_g \cdot T_g \cdot Z\left(P_{ave_2}\right)}$

$\rho_{ave3} = 0.168\dfrac{lb}{ft^3}$ $\quad$ $P_3 := P_2 - \Delta P_3$ $\quad$ $P_3 = 19.595\ psi$

$v_3 := \dfrac{Q_3}{\frac{\pi}{4} \cdot D_3^{\,2}}$ $\quad$ $Ma_3 := \dfrac{v_3}{c}$ $\quad$ $Ma_3 = 0.226$

For the globe valve, 1/2 open gv stands for globe valve, now going to 4 inch.

$D_p := 4in$

guess

$\rho_{avegv} := 0.149 \frac{lb}{ft^3}$ $\quad Q_{gv} := \frac{w_n}{\rho_{avegv}}$ $\quad Q_{gv} = 845.402 \frac{ft^3}{min}$

$v_{gv} := \frac{4Q_{gv}}{\pi \cdot D_p^2}$ $\quad \Delta P_{gv} := 9.5 \cdot \rho_{avegv} \cdot \frac{v_{gv}^2 \cdot f_f}{2g_c}$ $\quad \Delta P_{gv} = 5.978\ psi$

$P_{ave_3} := \left(\frac{2P_3 - \Delta P_{gv}}{2} + P_{atm} \right)$ $\quad P_{ave_3} = 29.107\ psi$

$\rho_{avegv} := \frac{P_{ave_3} \cdot MW_{air}}{R_g \cdot T_g \cdot Z\left(P_{ave_3}\right)}$ $\quad \rho_{avegv} = 0.149 \frac{lb}{ft^3}$

$P_4 := P_3 - \Delta P_{gv}$ $\quad P_4 = 13.618\ psi$

For the check valve (1 Swing check in air line) sv stands for check valve:

guess

$\rho_{avesv} := 0.13 \frac{lb}{ft^3}$ $\quad Q_{sv} := \frac{w_n}{\rho_{avesv}}$ $\quad Q_{sv} = 968.961 \frac{ft^3}{min}$

$v_{sv} := \frac{4Q_{sv}}{\pi \cdot D_p^2}$ $\quad \Delta P_{sv} := 2 \cdot \rho_{avesv} \cdot \frac{v_{sv}^2 \cdot f_f}{2g_c}$ $\quad \Delta P_{sv} = 1.442\ psi$

$P_{ave_4} := \frac{2P_4 - \Delta P_{sv}}{2} + P_{atm}$ $\quad \rho_{avesv} := \frac{P_{ave_4} \cdot MW_{air}}{R_g \cdot T_g \cdot Z\left(P_{ave_4}\right)}$ $\quad \rho_{avesv} = 0.13 \frac{lb}{ft^3}$

$P_5 := P_4 - \Delta P_{sv}$ $\quad P_4 = 13.618\ psi$

Flow to header, designate as p for pipe.

$P_5 - P_6 = \Delta P_p$ $\quad L_p := 58\,ft$

$$\rho_{avep} := 0.12\frac{lb}{ft^3} \qquad Q_p := \frac{w_n}{\rho_{avep}} \qquad Q_p = 1049.707\frac{ft^3}{min}$$

$$Re_p := \frac{4\cdot Q_p\cdot \rho_{avep}}{\pi\cdot D_p\cdot \mu_g} \qquad Re_p = 6.683\times 10^5$$

$$f_p := \frac{0.04}{Re_p^{\ 0.16}}$$

For rough estimates, use f for turbulent (Perry et al 1984)

$$\Delta P_p := \frac{32\cdot f_p\cdot \rho_{avep}\cdot L_p\cdot Q_p^{\ 2}\cdot f_f}{\pi^2\cdot D_p^{\ 5}\cdot g_c} \qquad \Delta P_p = 2.544\ psi \qquad P_{avep} = \frac{P_4 + P_5}{2}$$

$$Z(P_{ave}) := 1.101\times 10^{-8}\cdot\frac{1}{psi^2}\cdot(P_{ave})^2 - 2.286\times 10^{-5}\cdot\frac{1}{psi}\cdot P_{ave} + 1$$

$$P_{avep} := \frac{2P_5 - \Delta P_p}{2} + P_{atm} \qquad \rho_{avep} := \frac{P_{avep}\cdot MW_{air}}{R_g\cdot T_g\cdot Z(P_{avep})} \qquad \rho_{avep} = 0.12\frac{lb}{ft^3}$$

$$v_p := \frac{Q_p}{\frac{\pi}{4}\cdot D_p^{\ 2}} \qquad Ma_p := \frac{v_p}{c} \qquad Ma_p = 0.178$$

$$P_6 := P_5 - \Delta P_p \qquad P_6 = 9.632\ psi$$

Flow in pipe header, will use average from 5 segments h stands for pipe header. The L's are the lengths between sparge tubes.

$$L_1 := 10ft \qquad L_2 := 10\cdot ft \qquad L_3 := 10ft \qquad L_4 := 14ft$$

$$L_h := L_1 + L_2 + L_3 + L_4 \qquad L_h = 44\ ft$$

$$w_h := \frac{\left(\frac{4}{5}\cdot L_1 + \frac{3}{5}L_2 + \frac{2}{5}L_3 + \frac{1}{5}L_4\right)\cdot w_n}{L_h} \qquad w_h = 59.547\frac{lb}{min}$$

guess

$$\rho_{aveh} := 0.112\frac{lb}{ft^3} \qquad D_h := 4in \qquad Q_h := \frac{w_h}{\rho_{aveh}}$$

$$Q_h = 531.67\frac{ft^3}{min} \qquad Re_h := \frac{4\cdot Q_h\cdot\rho_{aveh}}{\pi\cdot D_h\cdot\mu_g} \qquad f_h := \frac{0.04}{Re_h^{\ 0.16}}$$

$$\Delta P_h := \frac{32\cdot f_h\cdot\rho_{aveh}\cdot L_h\cdot Q_h^{\ 2}\cdot f_f}{\pi^2\cdot D_h^{\ 5}\cdot g_c} \qquad \Delta P_h = 0.521psi \qquad P_{ave_6} := \frac{2P_6 - \Delta P_h}{2} + P_{atm}$$

$$v_h := \frac{Q_h}{\frac{\pi}{4}\cdot D_h^{\ 2}} \qquad Ma_h := \frac{v_h}{c} \qquad Ma_h = 0.09$$

$$\rho_{aveh} := \frac{P_{ave_6}\cdot MW_{air}}{R_g\cdot T_g\cdot Z\left(P_{ave_6}\right)} \qquad \rho_{aveh} = 0.112\frac{lb}{ft^3}$$

$$P_7 := P_6 - \Delta P_h \qquad P_7 = 9.111psi$$

For 5 sparge tubes (piping, split out into 10 at the ends, i.e., 2 nozzles off of each sparge tube) s stands for sparge tubes (pipes)

$$w_s := \frac{w_n}{5} \qquad w_s = 25.193\frac{lb}{min} \qquad D_s := 2in$$

$$L_s := 30\cdot ft \qquad L_s = 30\ ft$$

guess

$\rho_{aves} := 0.105\frac{lb}{ft^3}$ $\quad Q_s := \frac{w_s}{\rho_{aves}}$ $\quad Q_s = 239.933\frac{ft^3}{min}$

$Re_s := \frac{4 \cdot Q_s \cdot \rho_{aves}}{\pi \cdot D_s \cdot \mu_g}$ $\quad f_s := \frac{0.04}{Re_s^{0.16}}$

$\Delta P_s := \frac{32 \cdot f_s \cdot \rho_{aves} \cdot L_s \cdot Q_s^2 \cdot f_f}{\pi^2 \cdot D_s^5 \cdot g_c}$ $\quad \Delta P_s = 2.229psi$

$P_{ave_7} := \frac{2P_7 - \Delta P_s}{2} + P_{atm}$ $\quad P_{ave_7} = 20.496psi$ $\quad \rho_{aves} := \frac{P_{ave_7} \cdot MW_{air}}{R_g \cdot T_g \cdot Z\left(P_{ave_7}\right)}$

$\rho_{aves} = 0.105\frac{lb}{ft^3}$ $\quad P_8 := P_7 - \Delta P_s$ $\quad P_8 = 6.882psi$

Orifice pressure loss o stands for orifice

$P_{ave_8} := \frac{P_8 + 1.04psi}{2} + P_{atm}$ $\quad \rho_{aveo} := \frac{P_{ave_8} \cdot MW_{air}}{R_g \cdot T_g \cdot Z\left(P_{ave_8}\right)}$

$\rho_{aveo} = 0.084\frac{lb}{ft^3}$ $\quad C_v := 0.67$

$Q_o := \frac{w_n}{n \cdot \rho_{aveo}}$ $\quad v_o := \frac{Q_o}{\frac{\pi}{4} \cdot d_{o2}^2}$

$v_o = 443.256\frac{ft}{s}$ $\quad Ma := \frac{v_o}{c}$ $\quad Ma = 0.393$

$\Delta P_o := \frac{\rho_{aveo} \cdot v_o^2}{2 \cdot C_v^2} \cdot \left(1 - \frac{d_{o2}^4}{D_s^4}\right) \cdot f_f$ $\quad \Delta P_o = 5.949psi$

$$\rho_{aveo} := \frac{\left(\frac{2P_8 - \Delta P_o}{2} + P_{atm}\right) \cdot MW_{air}}{R_g \cdot T_g \cdot Z\left(P_{ave_8}\right)} \qquad \rho_{aveo} = 0.084 \frac{lb}{ft^3}$$

$P_9 := P_8 - \Delta P_o$ $\qquad$ $P_9 = 0.933 psi$

$\rho_s := 1.5 \frac{kg}{L}$ $\qquad$ $h_s := y$ $\qquad$ $\Delta P_h := \frac{\rho_s \cdot g \cdot h_s}{g_c}$

Tank head pressure loss, h stands for head

$\Delta P_h = 1.023 psi$ $\qquad$ $P_{10} := P_9 - \Delta P_h$ $\qquad$ $P_{10} = -0.09 psi$

$$\rho_g := \frac{\left(P_{atm} + P_9\right) \cdot MW_{air}}{R_g \cdot T_g} \qquad \rho_g = 0.069 \frac{lb}{ft^3}$$

$$Q := \frac{w_n}{\rho_g} \qquad Q = 1837.212 \frac{ft^3}{min}$$

Flow at PRV

$P_2 = 21 psi$ $\qquad$ $\rho_r := \frac{\left(P_2 + P_{atm}\right) \cdot MW_{air}}{R_g \cdot T_g}$ $\qquad$ $Q_{PRV} := \frac{w_n}{\rho_r}$

$Q_{PRV} = 736.703 \frac{ft^3}{min}$

Flow at compressor at 100 psi $\qquad$ $P_c := 100 psi + P_{atm}$

$\rho_c := \frac{P_c \cdot MW_{air}}{Z\left(P_c\right) \cdot R_g \cdot T_g}$ $\qquad$ $Q_{comp} := \frac{w_n}{\rho_c}$ $\qquad$ $Q_{comp} = 218.84 \frac{ft^3}{min}$

Flow at tank (atmospheric) conditions:

$$Q_{rated} := 250\frac{ft^3}{min}$$

$$Q_t := \frac{Q_{rated} \cdot P_c}{P_{atm}} \qquad Q_t = 2250\frac{ft^3}{min}$$

Want 2000, so OK

V. Generator Requirement and Diesel Consumption

Need to power the dryer, 2 heaters, and 1 fan

The fan is about 10 hp and estimate the dryer at about 5 kW

$$P_G := 10hp + \Delta h_{htr1} + \Delta h_{htr2} + 5kW \qquad P_G = 33.536kW$$

$$P_c := (100 + 12.5)psi \qquad R_p := \frac{P_c}{P_{atm}}$$

$$k := 1.4$$

$$P_{comp\_Q} := P_{atm} \cdot \frac{k}{k-1} \cdot R_p^{\frac{k-1}{k}-1} \qquad P_{comp\_Q} = 0.04\frac{hp \cdot min}{ft^3}$$

$$P_{comp} := P_{comp\_Q} \cdot Q_n \qquad P_{comp} = 79.479hp$$

Assume efficiency for compressor and generator at 50%. $\varepsilon_i := 50\%$

The total power for diesel: $P_{tot} := \frac{P_G + P_{comp}}{\varepsilon_i}$ $P_{tot} = 248.905\ hp$

$$bbl := 55gal$$

$$\Delta h_d := 5.2 \cdot 10^6 \frac{BTU}{bbl}$$

Diesel consumption: $wk := 7day$

$$r_d := \frac{P_{tot}}{\Delta h_d} \qquad r_d = 1125.365 \frac{gal}{wk}$$

VI. Flowsheet

To find the loadings for radionuclides, an entrainment function is needed. This was determined by plotting the upper curve of C' vs. DF in Figure 11-31 of Perry's 4th ed (Perry 1963). This provides a particulate entrainment for evaporating liquid, kg in vapor/kg liquid.

Where $C_{air} = \dfrac{G_{air}}{\sqrt{\rho_g \cdot (\rho_L - \rho_g)}}$ $\qquad G_{air} := \dfrac{Q_n \cdot \rho_g}{x \cdot L_{tk}}$

$$G_{air} = 18.05 \frac{lb}{ft^2 \cdot hr} \qquad C_{air} := \frac{G_{air}}{\sqrt{\rho_g \cdot (\rho_L - \rho_g)}} \qquad C_{air} = 8.728 \times 10^0 \frac{ft}{hr}$$

$$E_p := 2650.4 \left(\frac{C_{air}}{\mathrm{UnitsOf}(C_{air})} \right)^{-.3062} \qquad E_p = 2.411 \times 10^4 \frac{kg}{kg}$$

kg of vapor per kg of entrained liquid

Activity Definitions

$$Ci := 3.7 \cdot 10^{10} s^{-1} \qquad nCi := 10^{-9} Ci \qquad pCi := 10^{-12} Ci$$

Applying this to the radionuclides using Sr as an example (using total concentration as an example):

$$C_{Sr} := 1.11 \cdot 10^6 \frac{pCi}{gm} \qquad y_{Sr} := \frac{C_{Sr} \cdot \rho_g}{E_p} \qquad y_{Sr} = 5.057 \times 10^{-11} \frac{Ci}{L}$$

(A gas phase liquid concentration based on liquid/solid concentration)

$$y_{Sr} = 50.57 \frac{pCi}{L}$$

Compare this to plotting the data provided by Othmer (Othmer et al 2004).

$$v := \frac{Q_n}{x \cdot L_{tk}} \qquad v = 0.073 \frac{ft}{s}$$

$$E_o := 2.752 \cdot \left(\frac{v}{\mathrm{UnitsOf}(v)} \right)^{-1.9577} \qquad E_o = 4.718 \times 10^3 \frac{kg}{kg}$$

kg of vapor per kg of entrained liquid

The gas phase concentration is then:

$$y_{Sr} := \frac{C_{Sr} \cdot \rho_g}{E_o} \qquad y_{Sr} = 0.258 \frac{nCi}{L} \qquad \rho_g = 0.001 \frac{kg}{L}$$

Use the Othmer data since it is smaller (reciprocal is greater).

The emission rate equals the deposition rate assuming no DF for upstream equipment:

$$r_{Sr} := y_{Sr} \cdot Q_n \qquad r_{Sr} = 8.781 \times 10^{-4} \frac{Ci}{hr}$$

Metals

$$X_{met} := 51.6 \frac{mg}{kg} \qquad \mu g := 10^{-3} mg$$

$$y_{met} := \frac{X_{met} \cdot \rho_g}{E_o} \qquad y_{met} = 1.201 \times 10^{-2} \frac{\mu g}{L}$$

SVOCs

There are also naphthalene, TCE and xylenes:

define: $ppt_v := ppm_v \cdot 10^{-3}$

$MW_{nap} := 128\frac{gm}{mol}$ $MW_{xyl} := (7 \cdot 12 + 8) \cdot \frac{gm}{mol}$ $MW_{TCE} := 131.5\frac{gm}{mol}$

$X_{nap} := 0.0995\frac{mg}{kg}$ $X_{TCE} := 0.841\frac{mg}{kg}$ $X_{xyl} := 0.123\frac{mg}{kg}$

$$y_{napave} := \frac{M_{tk} \cdot X_{nap} \cdot 22.4\frac{L}{mol}}{Q_n \cdot MW_{nap} \cdot t_m} \qquad y_{napave} = 0.159ppt_v$$

$$y_{TCEave} := \frac{M_{tk} \cdot X_{TCE} \cdot 22.4\frac{L}{mol}}{Q_n \cdot MW_{TCE} \cdot t_m} \qquad y_{TCEave} = 1.31ppt_v$$

$$y_{xylave} := \frac{M_{tk} \cdot X_{xyl} \cdot 22.4\frac{L}{mol}}{Q_n \cdot MW_{xyl} \cdot t_m} \qquad y_{xylave} = 0.274ppt_v$$

It is a requirement to account for carcinogenic and non-carcinogenic compounds. It is expected that the SVOCs are small too but will determine a worse-case based on ratio with PCE and also entrainment similar to the radionuclides. The flowsheet will be classed as fused ring, aroclor 1260, phenols, and phthalates with the highest H/k_D for the group used. This will be estimated by ratio to the concentration and H/k_D of PCE.

Table C-2. SVOC Properties.

SVOCs	H, Latm/mol	K_{ow}, L/kg	K_{oc}	k_D, L/kg	H/k_D, kg-atm/mol	ratio to PCE	MW
Aroclor-1260	3.03E-01	5.01E+06	1.87E+06	2.22E+02	1.37E-03	8.40E-06	206.5
bis(2-ethylhexyl)Phthalate	8.33E-04	1.00E+03	6.17E+02	7.31E-02	1.14E-02	7.00E-05	390.57
Pentachlorophenol	2.50E-05	1.00E+02	6.17E+01	7.31E-03	3.42E-03	2.10E-05	266.34
Phenanthrene	3.57E-02	3.72E+04	1.89E+04	2.24E+00	1.60E-02	9.80E-05	178.23
PCE	1.70E+01	7.59E+02	8.78E+02	1.04E-01	1.63E+02		

For aroclor 1260: $X_{ar} := 7.33\frac{mg}{kg}$ $rat_{ar} := 8.4 \cdot 10^{-6}$

$$y_{ar} := y_{PCEave} \cdot rat_{ar} \cdot \frac{X_{ar}}{X_i} \qquad y_{ar} = 0.008\ ppt_v$$

Also check via entrainment:

The gas phase concentration is then:

$$y_{ar} := \frac{X_{ar} \cdot \rho_g}{E_o} \qquad y_{ar} = 1.706 \times 10^{-6} \frac{mg}{L}$$

Convert to ppt_V:

$$MW_{ar} := (2 \cdot 12 + 5 \cdot 35.5 + 5) \cdot \frac{gm}{mol} \qquad MW_{ar} = 206.5 \frac{gm}{mol}$$

$$y_{ar} := \frac{y_{ar} \cdot 22.4 \frac{L}{mol}}{MW_{ar}} \qquad y_{ar} = 1.851 \times 10^{-1} \, ppt_v$$

Therefore, entrainment leads to higher gas concentration than volatilization

The equation for combining these for the EXCEL flowsheet is:

$$y_{SVOC} = \left(\frac{y_{PCEave} \cdot rat_{SVOC}}{X_i} + \frac{\rho_g \cdot 22.4 \frac{L}{mol}}{MW_{SVOC} E_o} \right) \cdot X_{SVOC}$$

Note, the X_{SVOC} is the sum of all in that class with the MW used for the representative

Example for aroclor 1260:

$$y_{ar} := \left(\frac{y_{PCEave} \cdot rat_{ar}}{X_i} + \frac{\rho_g \cdot 22.4 \frac{L}{mol}}{MW_{ar} \cdot E_o} \right) \cdot X_{ar} \qquad y_{ar} = 0.193 ppt_v$$

VII. Miscellaneous

Pressure drop across stack

$$\varepsilon_T := 0.00152 mm \qquad D_{stk} := 10 in \qquad \rho_{H2O} := 1 \frac{kg}{L}$$

$$\varepsilon\_D := \frac{\varepsilon_T}{D_{stk}} \qquad \varepsilon\_D = 5.984 \times 10^{-6}$$

Close enough to zero for smooth tube

$L_{stk} := 12\,ft$ $\qquad$ $inH2O := \rho_{H2O} \cdot g \cdot 1in$

Find f by (Perry's 1984) $\qquad$ $Re_{stk} := \dfrac{4 \cdot Q_n \cdot \rho_g}{\pi \cdot D_{stk} \cdot \mu_g}$ $\qquad$ $Re_{stk} = 2.91 \times 10^5$

$$f := \left(\frac{1}{3.6 \cdot \log\left(\frac{Re_{stk}}{7}\right)} \right)^2 \qquad f = 0.004$$

$$\Delta P_{stk} := \frac{32 \cdot f \cdot \rho_g \cdot L_{stk} \cdot Q_n^{\,2}}{\pi^2 \cdot D_{stk}^{\,5}} \qquad \Delta P_{stk} = 0.159\ inH2O$$

Water removal rate

There is dry air coming in and could be saturated air coming out. The humidity of saturated air at 70°F is:

$H_{sat} := \dfrac{0.0158\ lb}{lb}$ $\qquad$ Moisture removal rate is: $\qquad$ $r_{H2O} := H_{sat} \cdot w_n$

$r_{H2O} = 1.99 \dfrac{lb}{min}$ $\qquad$ in terms of volume $\qquad$ $r_{H2O} := \dfrac{r_{H2O}}{\rho_L}$

$r_{H2O} = 2403.919\ \dfrac{gal}{wk}$ $\qquad$ so to maintain the water, need to add this much

Friction Plug Suck-In

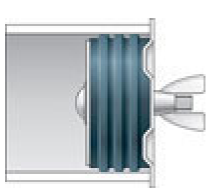


Figure C-11. Friction Plug

The Cherne Industry Econ-o-plug 4" model has allowed back-pressure of 2 psi so this is the limit on vacuum/pressure for it (see also time response below), i.e., if it will not pop it out at 2 psig, it will not suck it in at -2 psig.

Vent Line Collapse

Figure C-12. Vent Hose

This NFS/RPS is rated at -10"Hg to 21 psig. TIGG (the specified hose) has a range of -9.2"Hg to 4psi for 10" and -5.36"Hg to 3.5 psi for 12". Since this range is far larger than the flowsheet numbers, no collapse is expected (see also time response below).

Over/Under Pressure With Instrument Time Response

The following is uses many approximations and assumptions and demonstrates the conservative pressure increase and decrease of various scenarios in gas operations.

Assume fan failure at which time VFD-1 signals the solenoid SV-TMP-1 to close the valve.

Define milli-second $\quad ms := 10^{-3}s$

The length of time the signal takes to get to the valve is: $\quad \tau_{vs} := 5ms$

The length of time the valve takes to close is: $\quad \tau_v := 2s$

*Note, both these are conservative

By material balance:

$V_g := V_{tk} - V_{sl} \qquad P_{tk} := \frac{-1}{2}inH2O$

$$Q_i \cdot \frac{P_i \cdot MW}{R_g \cdot T_g} - Q_o \cdot \frac{P \cdot MW}{R_g \cdot T_g} = \frac{d}{dt}M \qquad P := \int \frac{w_n \cdot R_g \cdot T_g}{MW_{air} \cdot V_g}\,dt \qquad P_o := 0.85\,atm$$

$$Q_i \cdot \frac{P_i \cdot MW}{R_g \cdot T_g} - Q_o \cdot \frac{P \cdot MW}{R_g \cdot T_g} = \frac{d}{dt}M \qquad M = V_g \cdot \frac{P \cdot MW}{R_g \cdot T_g}$$

$$Q_i \cdot \frac{P_i \cdot MW}{R_g \cdot T_g} - Q_o \cdot \frac{P \cdot MW}{R_g \cdot T_g} = \frac{V_g \cdot MW}{R_g \cdot T_g} \cdot \frac{d}{dt} P$$

$Q_i \cdot P_i - Q_o \cdot P = V_g \cdot \frac{d}{dt} P$ $\quad Q_i := \frac{w_n}{\rho_r}$ $\quad Q_o := Q_n$ $\quad \tau_s := \frac{V_g}{Q_o}$ $\quad \tau_s = 187.739 \ s$

For fan failure use Q_o as zero for worst case

$P(t) = \frac{Q_i \cdot P_i}{V_g} \cdot t + C_1$ $\quad$ At $t = 0$, $P = P_{tk}$

$C_1 := P_{tk}$ $\quad P_i := (35 + 12.5) \cdot psi$

$$P(t) := \frac{Q_i \cdot P_i}{V_g} \cdot t + P_{tk}$$

$P\left(\tau_v + \tau_{vs}\right) = 4.672 \, inH2O$ $\quad$ 5 in water pressure before solenoid is closed

The case of if the solenoid fails closed or the switch inadvertently shut off leads to vacuum excursion. In this case Q_i is zero and Q_o falls off exponentially.

$dP = P_{atm} \cdot dp$ $\quad p = \frac{P}{P_{atm}}$ $\quad \tau_f := 10 \ s$ $\quad$ Estimated fan constant

Estimated fan signal transmission constants

Signal transducer to meter: $\quad \tau_{TM} := 200 \, ms$

Signal meter to fan controller: $\quad \tau_{MFC} := 200 ms$

Signal fan controller to fan: $\quad \tau_{FCF} := 200 \, ms$ $\quad \tau_{fs} := \tau_{TM} + \tau_{MFC} + \tau_{FCF}$

There are also the pneumatic transmission at the speed of sound through 30 ft of tubing, a 8 in^3 sediment bowl SB.

$V_{SB} := 8in^3$

Determine the RLC circuit for pneumatic signal (R = resistance, L = inductance, C = capacitance):

$D_t := \frac{1}{2}in$ $\qquad x_1 := 30ft$

$R_1 := \frac{128 \cdot \mu_g}{\pi \cdot D_t^4 \cdot g_c} \cdot \frac{P_{atm}}{9psi} \cdot x_1$ $\qquad R_1 = 0.00084 \frac{psi \cdot s}{in^3}$

$L_1 := \frac{\rho_g}{g_c} \cdot \frac{4}{\pi \cdot D_t^2} \cdot x_1$ $\qquad L_1 = 0.00019 \frac{psi \cdot s^2}{in^3}$

$C_1 := \frac{\frac{\pi}{4} \cdot D_t^2}{P_{atm}} \cdot x_1$ $\qquad C_1 = 5.655 \frac{in^3}{psi}$ $\qquad P_1 := 0.1inH2O$

$\frac{P_2}{P_1} = \frac{1}{s \cdot C_1 \cdot (R_1 + L_1 \cdot s) + 1}$ $\qquad P_2(s) := \frac{P_1}{[s \cdot C_1 \cdot (R_1 + L_1 \cdot s) + 1]}$

$\alpha_1 := C_1 \cdot R_1$ $\qquad \beta_1 := L_1 \cdot C_1$

since β_1 is << α_1, ignore β. [illegible].

Inverse Laplace

$\frac{P_2}{P_1} = \frac{1}{s} \cdot \frac{1}{\alpha_1 \cdot s + 1}$ $\qquad L^{-1}\left(\frac{1}{s} \cdot \frac{1}{\alpha_1 \cdot s + 1}\right) = 1 - exp\left(\frac{-t}{\alpha_1}\right)$

The SB resistance is the slope of the pressure over the flow which is essentially the same as for the tubing. Will combine the R's and C's for worse case.

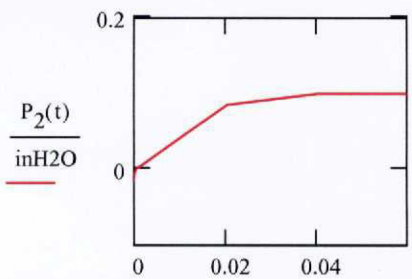
$R_2 := R_1$

$$C_2 := \frac{V_{SB}}{P_{atm}} \qquad\qquad C_2 = 0.64\frac{in^3}{psi}$$

$$\alpha_1 := (C_1 + C_2)\cdot(R_1 + R_2) \qquad\qquad \alpha_1 = 0.011s$$

$$P_2(t) := P_1\cdot\left(1 - \exp\left(\frac{-t}{\alpha_1}\right)\right)$$

Figure C-13. P vs. t, Fan Failure



SS at 60 ms for tubing and SB

Set the input air to zero:

$$\frac{-P}{P_{atm}}\cdot e^{\frac{-t}{\tau_f}} - \frac{P}{P_{atm}}\cdot\Phi(\tau_d - t) = \frac{\tau_s}{P_{atm}}\cdot\frac{d}{dt}P$$

The decaying fan (assumed to be exponential) plus the time delay by step function (Φ).

Set the delay time to the total fan system including pneumatic response:

$$\tau_d := \tau_{fs} + \alpha_1$$

$$p\cdot\left(e^{\frac{-t}{\tau_f}} + \Phi(\tau_d - t)\right) = \tau\cdot\frac{d}{dt}p \qquad\qquad \int \frac{1}{p}\,dp = \int \frac{1}{\tau}\cdot\left(e^{\frac{-t}{\tau_f}} + \Phi(\tau_d - t)\right)dt$$

$$\ln(p) = \frac{\left(-\tau_f \exp\left(\frac{-t}{\tau_f}\right) + t - \Phi(t - \tau_d)\cdot t + \Phi(t - \tau_d)\cdot\tau_d\right)}{\tau}$$

at t = 0, P/Patm = P_{tk}/Patm

$$\ln\left(\frac{P_{tk}}{P_{atm}}\right) = \frac{\tau_f}{\tau_s} + c \qquad\qquad c := \ln\left(\frac{P_{tk}}{P_{atm}}\right) + \frac{\tau_f}{\tau_s}$$

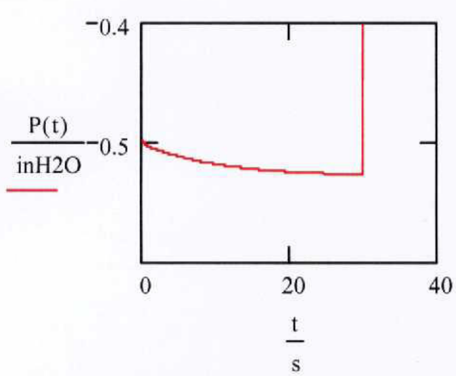
Add a pressure corrector so that there is essentially zero pressure after 3 fan time constants:

$$P_{corr}(t) := \Phi\left(t - 3\cdot\tau_f\right)\cdot\frac{0.536\,\mathrm{inH2O}}{P_{atm}}$$

Note, this is an artificial construct to get pressure back to zero.

$$p(t) := \exp\left[\frac{-\tau_f \cdot \exp\left(\frac{-t}{\tau_f}\right) + t - \Phi\left(t - \tau_d\right)\cdot t + \Phi\left(t - \tau_d\right)\cdot\tau_d}{\tau_s} + \left(\ln\left(\frac{P_{tk}}{P_{atm}}\right) + \frac{\tau_f}{\tau_s}\right)\right] + P_{corr}(t)$$

$P(t) := p(t)\cdot P_{atm}$ $\qquad P(0s) = -0.5\,\mathrm{inH2O}$ $\qquad P(25s) = -0.527\,\mathrm{inH2O}$



So this is OK, the instrument delay would need to be quite a bit higher to have an impact.

Figure C-14. P vs. t, Pressure Loss

Appears to be no problem with fan/pressure. Note this calculation could be a lot more complicated. However, there is pressure/vacuum relief and the variable drive controllers should brake the fan faster than the given wind-down.

Stack Structural at 90 mph wind

Drag force on stack:

$$F_d = \frac{C_d \cdot A_s \cdot \rho_g \cdot v^2}{2 \cdot g_c}$$

The drag coefficient (C_d) is a function of Re: Find Re for stack diameter.

$D_s := 10\text{in}$ $\quad v := 90 \frac{\text{mi}}{\text{hr}}$ $\quad H_s := 12\,\text{ft}$ $\quad L_s := 6\text{ft}$

$Re_s := \frac{D_s \cdot v \cdot \rho_g}{\mu_g}$ $\quad Re_s = 6.285 \times 10^5$ $\quad$ From Perry (Perry et al 1984) and Re> 10^6:

$C_d := 0.19 - \frac{8 \cdot 10^4}{Re_s}$ $\quad C_d = 0.063$ $\quad$ Note, this occurs after the drag "catastrophe" in Fig 5-76.

The projected area of the stack is: $\quad A_s := D_s \cdot H_s$

Initial, specified weight of sandbags

$F_d := \frac{C_d \cdot A_s \cdot \rho_g \cdot v^2}{2 \cdot g_c}$ $\quad F_d = 11.651\text{lbf}$ $\quad w_s := 200\text{ lbf}$

Using ASCE-7 (ASCE 1998): $\quad$ Note: the nomenclature used from ASCE-7 is not included

$A_f := A_s$ $\quad \frac{L_s}{D_s} = 7.2$ $\quad \frac{h}{D} = 7.2$ $\quad C_f := 0.6$

Use Exposure D, Table 6-5 ASCE-7

$K_z := 1.03$

Since it's flat: $\quad K_{zl} := 1$

From Table 6-4, 6-6: $\quad K_d := 0.95$

$V_z := v$ $\quad z := 7ft$ $\quad c := 0.15$

$I := 0.87$ I is importance factor

$q_z := 0.00256 \frac{lbf \cdot hr^2}{ft^2 \cdot mi^2} \cdot K_z \cdot K_{zt} \cdot K_d \cdot V_z^2 \cdot I$ $\quad q_z = 17.652 \frac{lbf}{ft^2}$

$l := 650ft$ $\quad \varepsilon_i := \frac{1}{8}$

$B := D_s$ $\quad h := L_s$ $\quad L_z := l \cdot \left(\frac{z}{33 \cdot ft}\right)^{\varepsilon_i}$

$$Q := \sqrt{\frac{1}{1 + 0.63 \cdot \left(\frac{B + h}{L_z}\right)^{0.63}}}$$ $\quad Q = 0.98$

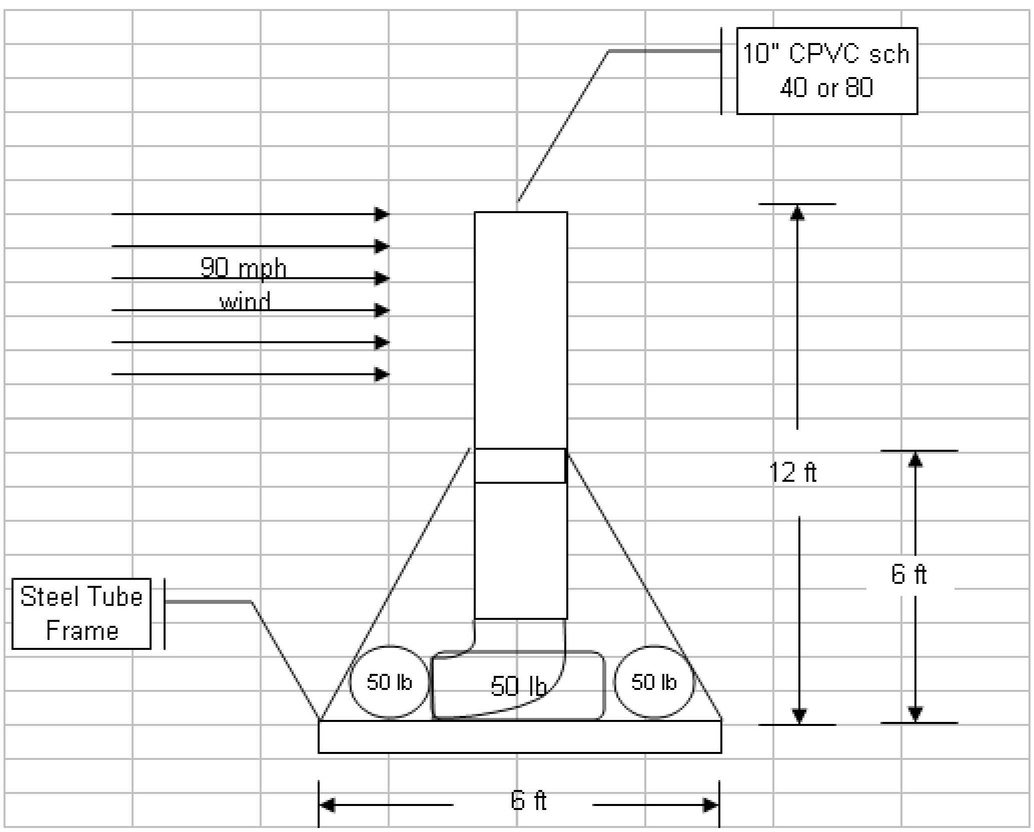


Figure C-15. Stack schematic.

$g_o := 3.4$ $\qquad$ $g_v := 3.4$

$n_1 := \frac{1}{s}$ $\qquad$ Since n_1, the natural frequency, is a guess, can also use the Gust factor = 1

$$g_R := \sqrt{2\cdot\ln(3600\,min\cdot n_1)} + \frac{0.577}{\sqrt{2\cdot\ln(3600\,s\cdot n_1)}} \qquad g_R = 5.099$$

$$N_1 := n_1\cdot\frac{L_z}{V_z} \qquad R_n := \frac{7.47\cdot N_1}{(1 + 10.3\cdot N_1)^{\frac{5}{3}}} \qquad R_n = 0.058$$

$$\eta := 4.6\cdot n_1\cdot\frac{h}{V_z} \qquad R_h := \frac{1}{\eta} - \frac{1}{2\cdot\eta^2}\cdot\left(1 - e^{-2\cdot\eta}\right) \qquad R_h = 0.874$$

$$\eta := 4.6\cdot n_1\cdot\frac{B}{V_z} \qquad R_B := \frac{1}{\eta} - \frac{1}{2\cdot\eta^2}\cdot\left(1 - e^{-2\cdot\eta}\right) \qquad R_B = 0.981$$

$L_i := D_s$

$$\eta := 15.4\cdot n_1\cdot\frac{L_i}{V_z} \qquad R_L := \frac{1}{\eta} - \frac{1}{2\cdot\eta^2}\cdot\left(1 - e^{-2\cdot\eta}\right) \qquad R_L = 0.938$$

$$R_f := \sqrt{\frac{1}{\beta}\cdot R_n\cdot R_h\cdot R_B\cdot(0.53 + 0.47\cdot R_L)} \qquad c := 0.15 \qquad I_z := \left(\frac{33ft}{z}\right)^{\frac{1}{6}}$$

$$G_f := 0.925\cdot\left(\frac{1 + 1.7\cdot I_z\cdot\sqrt{g_o^{\,2}\cdot Q^2 + g_R^{\,2}\cdot R_f^{\,2}}}{1 + 1.7\cdot g_v\cdot I_z}\right) \qquad G_f = 0.961$$

Because of uncertainty in n_1, use Gf = 1. $\qquad$ $G_f := 1$

$F_d := q_z\cdot G_f\cdot C_f\cdot A_f$ $\qquad$ $F_d = 105.915\ lbf$ $\qquad$ Higher than by basic method so use this as it includes resonance.

Overturn moment:

$$F_d \cdot \frac{H_s}{2} = F_x \cdot y$$

The stand width is: $b := 6\,\text{ft}$

Resisting moment needs to be at least:

$M_x := F_d \cdot H_s$ $\quad$ $M_x = 1270.977\ \text{ft} \cdot \text{lbf}$

$M_r := w_s \cdot \frac{b}{2}$ $\quad$ $M_r = 600\,\text{ft} \cdot \text{lbf}$ $\quad$ With 200 lb of sand, this could overturn

Sand needed since original 200 lb appears low:

$w_s := \frac{2 \cdot M_x}{b}$ $\quad$ $w_s = 423.659\ \text{lbf}$

or stand could be: $b := M_x \cdot \frac{2}{200\text{lbf}}$ $\quad$ $b = 12.71\ \text{ft}$

Check bending:

For the hydrostatic design basis (HDB), use 2500 psi which is conservative (http://www.ppfahome.org/ub2.html). Most nomenclature is from ASAHI Proline (Ziu 1986).

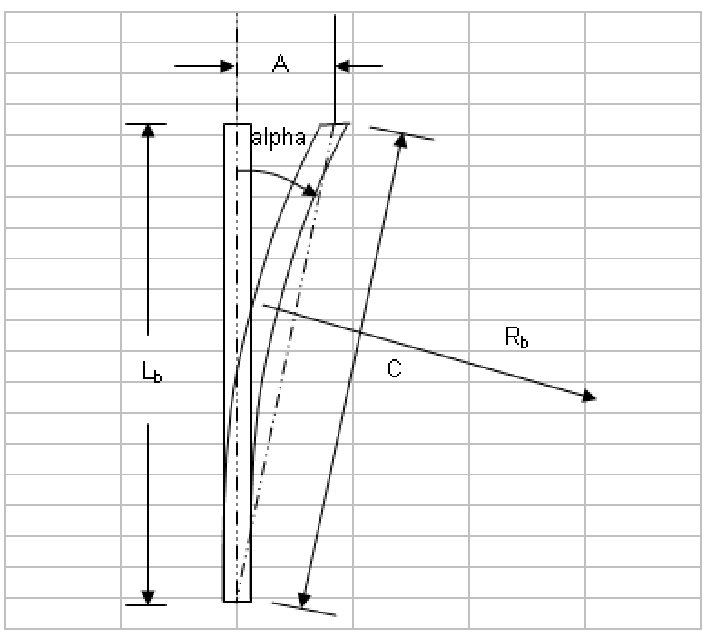


Figure C-16. Stack bending moment.

$f_d := 0.91$ This is for 90°F, a derating factor

The unrestrained length for bending is $H_s/2$ or 6 ft. $L_b := \frac{H_s}{2}$

$HDB := 2500psi$ The allowable bending stress is then: $S_b := \frac{HDB \cdot f_d}{4}$

Where the 4 in S_b is a assumed to be a safety factor provided (Ziu 1986)

The bending moment allowed is then:

$M = \frac{S_b \cdot I}{C_b}$ Need I (moment of inertia) and C_b:

For sch 80 CPVC: $D_{si} := 9.493in$ $D_{so} := D_{si} + 2 \cdot 0.593in$

$C_b := \frac{D_{so}}{2}$ $I_p := \frac{\pi}{64} \cdot \left(D_{so}^4 - D_{si}^4\right)$ $I_p = 0.012\ ft^4$

$M := \frac{S_b \cdot I_p}{C_b}$ $M = 2.128 \times 10^3\ ft \cdot lbf$ This is >> than maximum M_x

Modulus of elasticity for CPVC:

$E := 4.2 \cdot 10^5 psi$ $E = 6.048 \times 10^7 \frac{lbf}{ft^2}$

The minimum bending radius:

$R_{bmin} := \frac{E \cdot I_p}{M}$ $R_{bmin} = 328.585\ ft$

The central angle is:

$$\beta := \frac{360\ deg \cdot L_b}{2 \cdot \pi \cdot rad\ R_{bmin}} \qquad \beta = 1.046\ deg$$

The lateral deflection angle is:

$\alpha := \frac{\beta}{2}$ $\alpha = 0.523\ \mathrm{deg}$ $\sin(\alpha) = 0.009$

The offset is:

$A_{off} := 2 \cdot R_{bmin} \cdot (\sin(\alpha))^2$ $A_{off} = 0.055\ \mathrm{ft}$

The required force is:

$F_{req} := \frac{3 \cdot E \cdot I_p \cdot A_{off}}{L_b^{\,3}}$ $F_{req} = 5.32 \times 10^2\ \mathrm{lbf}$

Since this is > drag force, no bending problem expected.

Fan Curve Equation

From The fan curve

$$vx := \begin{pmatrix} 0 \\ 500 \\ 1000 \\ 1500 \\ 2000 \\ 2500 \\ 3000 \\ 3500 \end{pmatrix} \qquad vy := \begin{pmatrix} 19 \\ 18.5 \\ 17.9 \\ 16 \\ 13.6 \\ 10 \\ 7 \\ 2.4 \end{pmatrix} \qquad k := 2$$

$$\mathrm{regress}(vx, vy, k) = \begin{pmatrix} 3 \times 10^0 \\ 3 \times 10^0 \\ 2 \times 10^0 \\ 1.902 \times 10^1 \\ -5.714 \times 10^{-5} \\ -1.343 \times 10^{-6} \end{pmatrix}$$

$$\Delta p_{fan} = -1.343 \times 10^{-6} \cdot Q^2 - 5.714 \times 10^{-5} \cdot Q + 19.02$$

GAC ΔP Equation

From TIGG data for N1000

$$vx := \begin{pmatrix} 250 \\ 500 \\ 750 \\ 1000 \end{pmatrix} \qquad vy := \begin{pmatrix} 0.4 \\ 1 \\ 1.9 \\ 3.1 \end{pmatrix} \qquad k := 2$$

$$\text{regress}(vx, vy, k) = \begin{pmatrix} 3 \times 10^{0} \\ 3 \times 10^{0} \\ 2 \times 10^{0} \\ 10 \times 10^{-2} \\ 6 \times 10^{-4} \\ 2.4 \times 10^{-6} \end{pmatrix}$$

Note, for GAC Q is standard

$$\Delta P_{GAC} = 2.4 \times 10^{-6} \cdot Q^2 + 6 \times 10^{-4} \cdot Q + 0.01$$

HEPA ΔP Equation

$$vx := \begin{pmatrix} 0 \\ 1000 \\ 1500 \\ 2000 \end{pmatrix} \qquad vy := \begin{pmatrix} 0 \\ 1 \\ 1.3 \\ 1.9 \end{pmatrix} \qquad k := 2$$

$$\text{regress}(vx, vy, k) = \begin{pmatrix} 3 \times 10^{0} \\ 3 \times 10^{0} \\ 2 \times 10^{0} \\ 1.182 \times 10^{-2} \\ 9.082 \times 10^{-4} \\ 9.091 \times 10^{-9} \end{pmatrix}$$

$$\Delta P_{HEPA} = 9.091 \times 10^{-9} \cdot Q^2 + 9.082 \times 10^{-4} \cdot Q + 1.182 \times 10^{-2}$$

General ΔP Equation

In general, and for scoping, the pressure drops are estimated from known ΔP's.

Filters, HEPAs, demisters, etc. $\Delta P = C \cdot Q^2$

Duct, pipe, etc. $\Delta P = \frac{C \cdot Q^2}{D^5}$

With the C's found from the known condition. Note that flex duct has more ΔP in a compressed condition than stretched. A compression factor of 2 was used.

For a general pipe:

$$f = \left(\frac{1}{3.6 \cdot \log\left(\frac{Re}{7}\right)} \right)^2 \quad \text{or} \quad f = \frac{0.04}{Re^{0.16}}$$

Perry et al 1984

$$\Delta P = \frac{32 \cdot f \cdot \rho_g \cdot L \cdot Q_n^{\,2}}{\pi^2 \cdot D^5}$$

Attachment 4

Air Permitting Applicability Determination

AIR PERMITTING APPLICABILITY DETERMINATION

Note: This completed form serves as official transmittal and documentation of the Environmental Affairs (EA) Air Permitting Applicability Determination (APAD) and is approved based on the information and project description supplied by a Project Manager or Designee. This form is the official means of documenting APAD review, and specifies project specific permitting actions required and/or operating conditions for the emission of air pollutants, or 40 CFR 68 requirements for storage of regulated chemicals. Unless operation or construction is initiated within one year (or as otherwise noted in the APAD), the APAD is valid for one year from the Issuance Date. If project operation or construction is not initiated within one year of the Issuance Date, or the Project Manager or Designee fails to provide project status or a revision request to EA, the APAD will be rescinded. Project status is made using INEEL Form 450.31.
The calculations used herein are performed in accordance with approved environmental protocols, and therefore may not suffice for use in health, safety, or radiological control evaluations.

Section A. Document Concurrence

Instructions: The APAD Document Preparer shall sign the appropriate block and obtain the signature of the APAD Technical Reviewer and the Project Manager. Additional signatures may be obtained at the request of cognizant EA, facility, or project personnel.

Project Title: TSF-26 PM-2A CERCLA Tank Treatment Project

APAD Issuance Date: ____________ NEPA Document or Project Number: NA

APAD Tracking Number: 04-13, Revision 3

APAD Document Preparer:
I have prepared this document in accordance with applicable requirements and regulatory agency guidance, and I verify it is true, accurate, and complete to the best of my knowledge.

J. W. Tkachyk	James W. Tkachyk	4/26/05
Print/Type Name	Signature	Date

APAD Technical Review (Must complete APAD Appendix B Checklist):
I have reviewed this document for technical accuracy and content, including the validation of calculations where applicable, and concur that it is true, accurate, and complete to the best of my knowledge.

D. L. Eaton	[signature]	4/27/05
Print/Type Name	Signature	Date

Project Manager (Must complete APAD Appendix C Checklist):
I concur that based on my inquiry of the person(s) who prepared this document, and/or the person(s) directly responsible for gathering or providing the information, the document is true, accurate, and complete to the best of my knowledge.

A. K. Yonk	Alan K. Yonk	4/27/05
Print/Type Name	Signature	Date

Technical Checker
I concur that based on my inquiry of the person(s) who prepared this document, and/or the person(s) directly responsible for gathering or providing the information, the document is true, accurate, and complete to the best of my knowledge.

R. P. Keegan	Raymond Keegan	4/26/05
Print/Type Name	Signature	Date

Title: Facility Manager
I concur that based on my inquiry of the person(s) who prepared this document, and/or the person(s) directly responsible for gathering or providing the information, the document is true, accurate, and complete to the best of my knowledge.

S. M. Edgett	S. M. Edgett	4/26/05
Print/Type Name	Signature	Date

Title: APAD Technical Review
I concur that based on my inquiry of the person(s) who prepared this document, and/or the person(s) directly responsible for gathering or providing the information, the document is true, accurate, and complete to the best of my knowledge.

K. M. Wendt	Kraig M. Wendt	4-26-05
Print/Type Name	Signature	Date

Title: ____________
I concur that based on my inquiry of the person(s) who prepared this document, and/or the person(s) directly responsible for gathering or providing the information, the document is true, accurate, and complete to the best of my knowledge.

Print/Type Name	Signature	Date

Section B. Common APAD Acronyms

AEI	Air Emissions Inventory	APAD	Air Permitting Applicability Determination
ARAR	Applicable or Relevant and Appropriate Requirements	BRC	Below Regulatory Concern
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act	EA	Environmental Affairs
EC	Environmental Checklist	EPA	United States Environmental Protection Agency
IDAPA	Idaho Administrative Procedures Act	IDEQ	Idaho Department of Environmental Quality
NEPA	National Environmental Policy Act	NESHAP	National Emissions Standard for Hazardous Air Pollutants
PSD	Prevention of Significant Deterioration	PTC	Permit To Construct
RMP	Risk Management Plan	TAP	Toxic Air Pollutant
WAG	Waste Area Group		

Section C. Air Permitting Applicability Determination

Instructions: Indicate determination by checking the appropriate box. The appropriate "No Permitting Required" box must be checked for any "Category I" or "Category II Exemption." A Below Regulatory Concern (BRC), Level 1, 2, or 3 determination must also be checked for any Category I or II Exemption for which Toxic Air Pollutants (TAPs) are documented.

- ☐ Permit to Construct (PTC) Required from Regulatory Agency
- ☐ PTC Modification Required from Regulatory Agency
- ☐ Category I Exemption:
  TAPs : ☐ BRC; ☐ Level 1; ☐ Level 2; ☐ Level 3
- ☐ Category II Exemption:
  TAPs: ☐ BRC; ☐ Level 1; ☐ Level 2; ☐ Level 3
- ☐ Risk Management Plan Required
- ☐ NESHAP Approval to Construct Required
- ☐ Further Evaluation for Permitting Required
- ☐ No Permitting Required, Without Conditions
- ☐ No Permitting Required, With Conditions (See Sections E, F, & G)
- ☒ No Permitting Required, CERCLA Action with Conditions (Must Meet ARARs, See Sections E, F, & G)

Section D. Brief Description of Air Pollutant Emitting Aspects of Proposed Activity

Instructions: Include in this section a brief description that summarizes the scope of the project, the facility affected, whether the facility currently has emissions, and a summary of emission impacts caused by the proposed project. Information such as a paraphrased summary of the project description in an Environmental Checklist (EC), location, vents, and horsepower ratings for engines, should be included. Documents (including relevant letters, relevant e-mails, written records of personal communications, etc.) upon which this description is based must be included in the APAD information file. Date and identify the source of information for all material placed in this APAD and the APAD information file.

The proposed method of treatment for the Technical Support Facility (TSF)-26 PM-2A tank V-14, previously located at the Idaho National Engineering and Environmental Laboratory (INEEL) Test Area North (TAN) is to be treated by air sparging. The activity supports a CERCLA remedial action at the INEEL for the TAN Operable Unit (OU) 1-10. The approximate 46,000 lbs of waste from this tank will be treated at the Idaho CERCLA Disposal Facility (ICDF).

This evaluation is not dependent on the type of treatment technology chosen, so long as the assumptions used for the emission calculations remain valid. Depending on whether further sampling and characterization of the PM-2A tanks is necessary, future analytical results may show higher (or lower) concentrations of waste constituents. If the concentrations are higher than those used in this evaluation, additional calculations should be performed to determine that the applicable limits will not be exceeded.

The use of a 78 HP diesel generator to be used by this project can be exempted by APAD-1-83, *Mobile Sources Nonroad engines Generic coverage for diesel engines less than 294 HP,* since the engine is a non-road diesel engine less than 294 HP.

Section E. Impacts and Summary of Applicable Regulations

Instructions: Based upon review of applicable project information, regulations, agency guidance, and EA regulatory clarification documents, check all boxes for which the project may incur regulatory impact or requirement.

- ☒ Change in Stack Parameters
- ☒ CERCLA Remedial Action
- ☐ Excess Emissions Reporting
- ☐ Demolition Notification
- ☐ Fuel Sulfur Content
- ☐ Fuel Burning Equipment Particulate Matter
- ☐ Fugitive Dust Control
- ☐ NESHAP Asbestos Notification
- ☐ Air Emissions Inventory
- ☐ NESHAP Continuously Monitored Radionuclide
- ☒ NESHAP Radionuclide Actual Emissions
- ☐ Title V Operating Permit

- ☒ NESHAP Unabated Radionuclide Emissions
- ☐ Open Burning
- ☐ Portable Equipment Registration
- ☐ Subcontractor Permitting/Registration
- ☐ Risk Management Plan
- ☐ Notification of Emissions Change
- ☐ Particulate Matter Process Weight Limitations
- ☐ Subcontractor Internal Combustion Engine(s)
- ☒ Visible Emissions
- ☐ None

Section F. Summary of Requirements of Operations

Instructions: For each impact checked in Section E, cite the regulation and summarize the applicable requirements.

Change in Stack Parameters - The performing organization Project Manager shall notify Environmental Compliance in a timely manner of any proposed change and/or removal of this air emissions source.

CERCLA Remedial Action - Remedial action must meet the substantive requirements of the Clean Air Act (CAA), which are considered either Applicable or Relevant and Appropriate Requirements (ARARs), and may include State of Idaho and Federal requirements. The performing organization Project Manager shall ensure that project personnel calculate emissions from this project and maintain documentation of the emissions calculations on file.

NESHAP Radionuclide Actual Emissions - All radiological emissions to the environment, including those from all point and diffuse sources, must be determined for demonstrating compliance with the NESHAP Standard [see CFR 61.93 (a)] and submitted for reporting in the INEEL NESHAP's Annual Report per 40 CFR 61.94.

NESHAP Unabated Radionuclide Emissions - The unabated radiological emissions to the environment which must be calculated for each affected stack or vent, must be calculated/measured annually per 40 CFR 61.93 (b)(4)(i) (periodic confirmatory measurement).

Visible Emissions - IDAPA 58.01.01.625 - A person shall not discharge any air pollutant into the atmosphere from any point of emission for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period which is greater than twenty percent (20%) opacity.

Section G. Facility/Project Tasks for Demonstration of Compliance to Requirements

Instructions: For each requirement presented in Section F, specify in Part II below detailed actions that Facility/Project personnel must take to adequately demonstrate compliance. This includes identifying required reports/notifications (including due dates), documenting the manner in which throughput limitations are to be met, identifying required monitoring methods and frequency, specifying record keeping frequency, and providing details on any specific tasks necessary to document actual or potential emissions. State "No Compliance Tasks" for any requirement in Section F for which Facility/Project personnel have no responsibilities.

Part I: Facility/Project task responsibilities <u>applicable to all projects</u>:

A The Facility Manager or Designee shall ensure this APAD is maintained with its associated information file at an on-site location (See Appendix C for facility identified storage location)

B The Facility Manager or Designee, using the INEEL Form 450.31, shall provide to EA Policy and Permitting, an annual notification of project status, and one-time notification within 30 days after any of the following:

1. Construction - not applicable
2. Startup - not applicable
3. Completion - not applicable
4. Cancellation

C The Project Manager or Designee shall provide advance written notification to EA Policy and Permitting as soon as possible if the project scope changes. Notification to EA is necessary to ensure the APAD is accurate and complete for a proposed scope change.

Part II: Facility/Project task responsibilities <u>specific to this project</u>:

1. Change in Stack Parameters - The performing organization Project Manager shall notify Environmental Compliance in a timely manner of any proposed change and/or removal of this air emissions source. Contact the project environmental lead for additional guidance.

2. CERCLA Remedial Action - ARARs applicable to this project are compliance with IDAPA 58.01.01.220 and 40 CFR Part 61 Subpart H. Section I of this APAD (Justification for APAD) documents that the approval/exemption requirements of IDAPA 58.01.01.220 and 40 CFR Part 61 Subpart H are met. In addition to documenting that the applicable approval/exemption requirements are met, the ARARs also include the determination and reporting of actual and potential radionuclide emissions as listed in this APAD under Section G Part II 4-5. The performing organization Project Manager shall ensure this project's emissions are reported as required. Emission calculations should be maintained in the appropriate project file.

3. NESHAP Radionuclide Actual Emissions **-** The performing organization Project Manager shall ensure that this project's actual radionuclide emissions contribution are determined and reported to the project environmental lead.

   Note: Calculations and emissions identified in this APAD may be used to satisfy all or part of the reporting requirements as advised by the project environmental lead.

4. NESHAP Unabated Radionuclide Emissions – The performing organization Project Manager shall ensure that this project's potential (unabated) radiological emissions are determined annually per 40 CFR 61.93(b)(4)(i) (periodic confirmatory measurement) and report the unabated results as specified in MCP-3480 to the project environmental lead.

   Note: Calculations and emissions identified in this APAD may be used to satisfy all or part of the reporting requirements as advised by the project environmental lead. Periodic confirmatory measurements requirements are satisfied by using the calculations located in Appendix A, Table A-1 of this APAD.

5. Visible Emissions – No compliance demonstration required.

6. Potential to Emit **-** This APAD was based on several factors which were considered part of the physical and operational design of this emission source. The facility manager shall ensure that the corresponding emission levels are not exceeded. Emissions shall be documented in project files and compiled as appropriate to demonstrate compliance with the requirements of this APAD. For increases in emissions or change of activity, contact the project environmental lead for an air emissions evaluation prior to implementing the change.

7. Nonroad diesel engines see exempted per APAD-01-83. See visible emissions in Section F of this APAD for requirements.

Section H. Summary of Applicable Environmental Reports Performed by Environmental Affairs

Instructions: Based on the presence of regulated air pollutants documented in this APAD and the applicability of regulatory requirements, check the appropriate boxes below to indicate those reports and documents prepared by EA that are impacted by this APAD.

☐ Air Emissions Inventory	☐ Title V Air Operating Permit
☐ Annual Toxics Report	☐ NESHAP Continuous Compliance Monitoring
☒ NESHAP Annual Report	☒ NESHAP Periodic Confirmatory Monitoring
☐ PSD Quarterly Report	☐ Risk Management Plan
☐ Semi-Annual Continuous Compliance Report	☐ None

Section I: Justification for APAD

Instructions: Cite the regulation upon which the determination is based, and document how the project meets each condition of the regulation. Background documentation, including emission calculations and modeling, which substantiates the determination, must be included in Appendix A.

This project supports a CERCLA remedial action, and as such must meet the substantive requirements of the Clean Air Act which are considered ARARs. The ARARs for this project are demonstration of compliance with the substantive requirements of Idaho Administrative Procedures Act (IDAPA) 58.01.01.220 and 40 CFR Part 61 Subpart H. The project is not required to meet administrative requirements (permitting, notifications, etc).

This evaluation was performed to document that uncontrolled emissions of criteria air pollutants will be less than the significant emission levels identified in IDAPA 58.01.01.006.93. Therefore, the project emissions are not be subject to the requirements associated with a detailed permitting/impact analysis, such as a Prevention of Significant Deterioration (PSD) review, increment consumption analysis, and installation of Best Available Control Technology (BACT). This evaluation shows that potential uncontrolled emissions of criteria air pollutants will not cause a violation of an ambient air quality standard in accordance with IDAPA 58.01.01.577.

This evaluation shows that uncontrolled emissions of non-carcinogenic toxic air pollutants and several carcinogenic toxic air pollutants are less than the screening emission levels. Emissions of all toxic air pollutants will not exceed the acceptable ambient concentrations as listed in IDAPA 58.01.01.585 and 586.

This evaluation shows that uncontrolled radionuclide emissions will not exceed the 0.1 mrem/yr trigger level as referenced in 40 CFR Part 61 Subpart H. Therefore, the continuous monitoring requirement of 40 CFR Part 61 Subpart H is not applicable to this project. As stated in Section G Part II of this APAD, compliance with the 10 mrem/yr dose standard for the INEEL site and the reporting requirements of 40 CFR Part 61 Subpart H are applicable.

For all air pollutants, this evaluation demonstrates that installation and operation of air pollution control equipment to control emissions is not required by the Clean Air Act.

STATE REGULATIONS

IDAPA 58.01.01 RULES FOR THE CONTROL OF AIR POLLUTION IN IDAHO

IDAPA 58.01.01.161 TOXIC SUBSTANCES.
Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.

Justification: No contaminant will be emitted in such quantities or concentrations that will injure or unreasonably affect human or animal life or vegetation. As referenced in IDAPA 58.01.01.203, the methods of IDAPA 58.01.01.210 were used to demonstrate compliance with this requirement. Potential emissions of toxic air pollutants will not exceed the acceptable ambient concentrations identified in IDAPA 58.01.01.585 and 586. Refer to Appendix A, Tables A-1 and A-2 for toxic air pollutant emission calculations and comparison to the screening emission levels and acceptable ambient concentration criteria. The criterion is satisfied.

IDAPA 58.01.01.203. PERMIT REQUIREMENTS FO NEW AND MODIFIED STATIONARY SOURCES.
No permit to construct shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of the Department all of the following:

01. Emission Standards. The stationary source or modification would comply with all applicable local, state or federal emission standards.

Justification: The source will comply with all substantive local, state and federal emission standards. Emissions of criteria air pollutants will be would be less than the significant emission levels identified in IDAPA 58.01.01.006.93 and will not cause or significantly contribute to a violation of an air quality standard. Emissions of toxic air pollutants will not exceed the acceptable ambient concentrations as listed in IDAPA 58.01.01.585 and 586. Emissions of radionuclides will not exceed one (1%) of the applicable 10 mrem/yr radionuclide dose standard as referenced in 40 CFR Part 61 Subpart H. Refer to Appendix A, Tables A-1 through A-2 for evaluation of toxic air pollutant emissions. Refer to Table A-3 for evaluation of radionuclide emissions. Refer to Table A-4 for evaluation of criteria air pollutant emissions. Refer to Table A-5 for evaluation of compliance with the ambient air quality standards. The criterion is satisfied.

02. NAAQS. The stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard.

Justification: The source will be located in an attainment or unclassifiable area; therefore, emissions could not significantly contribute to a violation where no violation of an ambient air quality standard has occurred. The projected ambient concentrations will not cause a violation of an ambient air quality standard. Refer to Appendix A, Table A-5 for ambient impact analysis. The criterion is satisfied.

03. Toxic Air Pollutants. Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.

Justification: Using the methods provided in IDAPA 58.01.01.210, the projected emissions of toxic air pollutants will comply with IDAPA 58.01.01.585 and 586 standards. Uncontrolled emissions of non-carcinogenic toxic air pollutants and several carcinogenic toxic air pollutants from this project will be less than the applicable screening emission levels. Uncontrolled emissions of all toxic air pollutants from this project will be less than the acceptable ambient concentrations. Refer to Appendix A, Tables A-1 and A-2 for toxic air pollutant emission calculations and comparison to the screening emission levels and acceptable ambient concentration criteria. The criterion is satisfied.

IDAPA 58.01.01.220. CRITERIA FOR PERMIT TO CONSTRUCT EXEMPTIONS.

01. General Exemption Criteria. Sections 220 through 223 may be used by owners or operators to exempt certain sources from the requirement to obtain a permit to construct. Nothing in these sections shall preclude an owner or operator from choosing to obtain a permit to construct. For purposes of Sections 220 through 223, the term source means the equipment or activity being exempted. No permit to construct is required for a source that satisfies all of the following criteria, in addition to the criteria set forth at Sections 221, 222, or 223: (4-5-00)

Justification: This purpose of the evaluation of IDAPA 58.01.01.220 general exemption requirements is to show that this project does not trigger any additional requirements for the INEEL as a major stationary source.

   a. The maximum capacity of a source to emit an air pollutant under its physical and operational design without consideration of limitations on emission such as air pollution control equipment, restrictions on hours of operation and restrictions on the type and amount of material combusted, stored or processed would not: (4-5-00)

i. Equal or exceed one hundred (100) tons per year of any regulated air pollutant. (4-5-00)

Justification: Emissions from this air emission source will not equal or exceed one hundred (100) tons per year of any regulated air pollutant. Refer to Appendix A, Tables A-1 through A-4 for emission calculations. The criterion is satisfied.

ii. Cause an increase in the emissions of a major facility that equals or exceeds the significant emissions rates set out in the definition of significant at Section 006. (4-5-00)

Justification: The emissions from this project will not cause an increase in emissions that equals or exceeds the significant mission rates set out in Section 006. Refer to Appendix A, Table A-4 for emission calculations. The criterion is satisfied.

iii. Cause or significantly contribute to a violation of an ambient air quality standard, based upon the applicable air quality models, data bases, and other requirements of 40 CFR Part 51, Appendix W (Guideline on Air Quality Models). No demonstration under this subsection is required for those sources listed at Subsection 222.02. (4-5-00)

Justification: The project will not cause or significantly to a violation of an ambient air quality standard. Refer to Appendix A, Table A-5 for ambient impact calculations. The criterion is satisfied.

b. Combination: The source is not part of a proposed new major facility or part of a proposed major modification. (4-5-00)

Justification: This project is not part of a proposed new major facility or part of a proposed major modification as defined in IDAPA 58.01.01.006. The criterion is satisfied.

FEDERAL REGULATIONS

40 CFR 61, SUBPART H – NATIONAL EMISSION STANDARDS FOR EMISSION OF RADIONUCLIDES OTHER THAN RADON FROM DEPARTMENT OF ENERGY FACILITIES.

40 CFR 61.93 Emission monitoring and test procedures. In order to determine whether a release point is subject to the emission measurement requirements of 40 CFR 61.93.b (continuous monitoring), it is necessary to evaluate the potential for radionuclide emissions for the release point. In evaluating the potential of a release point to discharge radionuclides into the air for purposes of continuous monitoring, the estimated radionuclide release rates shall be based on the discharge of the effluent stream that would result if all pollution control equipment did not exist, but the facilities operations were otherwise normal. Sources with unmitigated potential emissions determined to equal or exceed 0.1 mrem/yr are required to be continuously monitored.

Justification: As demonstrated in Appendix A, Table A-3, potential unabated EDE from this project was calculated to below the 0.1 mrem/yr continuous monitoring threshold. The requirement for continuous monitoring is not applicable to this project.

Section J: Toxic Air Pollutant Emission Information

Instructions: Upon identifying the presence of applicable toxic air pollutants for the project, the APAD Document Preparer shall identify the specific pollutants and document their emission rates. Refer to IDAPA 58.01.01.585 and 586 to complete this section. If no TAPs are expected to be present, state "None" or "N/A".

See Appendix A, Tables A-1 and A-2 for list of potential toxic air pollutants and emission calculations.

Appendix A. Project Emissions

Instructions: Include sample calculations and a summary of emissions results. (Modeling results must be attached for any modeling that has been conducted.) Reference all assumptions and documentation upon which the calculations are based, including relevant documents, letters, e-mails, written records of personnel communication, and all variables in calculations. Include the formula view (if available) or provide example equations for any electronic worksheets calculating emission values.

AIR POLLUTANT EMISSIONS CALCULATIONS AND ASSUMPTIONS

Refer to Tables A-1 through A-5 for emission calculations and comparison to emission standards.

Methods and Assumptions:

1. Waste constituent data was obtained from document entitled "EDF-4830, Waste Generator Services Closure Report for the Contents of the PM-2A Tanks (TSF-26)", Table 3, Analytical results for Tank V-14 with the highest activity found in any one sample assumed to represent worst case activity of the entire waste contents. The data provides measured concentrations in each of the PM-2A waste tank(V-14). The highest concentration found in any one sample was assumed to represent worst case concentration of the entire waste contents.
2. Assume a maximum of 46,000 lbs of waste in the tank.
3. For comparison with short-term emission limits (e.g., lb/hr), it was assumed that the entire tank waste volume could be processed in 240 hrs (approximately 10-24 hour days), with volatile species being released in the first hour and the non-volatile species being released uniformly over the 240 hour period.
4. All particulate matter (PM) is assumed to be PM less than 10 micrometers in aerodynamic diameter (PM-10).
5. If the radionuclide exists as a liquid or particulate solid, a release fraction of 1E-03 (0.001) is used to estimate potential emissions (see 40 CFR Part 61, Appendix D). A release fraction of 1 is assumed for gaseous or volatile radionuclides.
6. During treatment, metals present in the waste are assumed released using a release fraction of 0.001, equivalent to that used for radionuclide release rate calculations.
7. During treatment, volatile and semi-volatile organic compounds are assumed released using a release fraction of 1.
8. The TAP screening emission levels and acceptable ambient concentration limits associated with the most toxic or carcinogenic form were used for comparison with the waste constituents. For example, all chromium present in the waste is assumed to be present as hexavalent chromium (Cr VI).
9. A density of 1.6 g/mL was used in emission calculations to bound potential emissions.
10. In accordance with IDAPA 58.01.01.586, the following polyaromatic hydrocarbons (PAH) were considered together as one toxic air pollutant: benzo(a)anthracene, benzo(b)fluoranthene, chrysene, indenol(1,2,3,-cd)pyrene, and benzo(a)pyrene. These were compared to the IDAPA 58.01.01.586 levels for POC, equivalent to benzo(a)pyrene (e.g., 2.0E-06 lb/hr and 3.0E-04 ug/m^3).
11. In accordance with IDAPA 58.01.01.586, the remaining PAH compounds (fluoranthene, pyrene, and benzo(g,h,i)perylene) were considered together as one toxic air pollutant and compared to the IDAPA 58.01.01.586 levels for PAH (e.g., 9.1E-05 lb/hr and 1.4E-02 ug/m^3).
12. No credit for control equipment is assumed.

CAP-88 MODEL

Methods and Assumptions:

1. The effective dose equivalent was determined using CAP-88 to model a one (1) Ci release to the maximally exposed individual (MEI) at Frenchman's Cabin from INTEC. The unit curie dose (mrem/Ci) is used as a factor to multiply the maximum potential emission rate (Ci/yr) to determine the potential EDE (mrem/yr). This method assumes the current MEI at Frenchman's Cabin will not move closer to ICDF during the course of this activity. Unit curie dose factors are based on 10 year met average provided by C. S. Staley.

SCREEN3 MODEL

Methods and Assumptions:

1. SCREEN3, version 96043, was used.
2. The point of compliance for criteria air pollutants and non-carcinogenic toxic air pollutants was determined to be the nearest public highway (Hwy 20), 4,845 m distant from ICDF. The point of compliance for carcinogenic toxic air pollutants was determined to be the closest INEEL site boundary, 12,716 m distant from ICDF. Emissions were modeled without consideration of building wake effects. Two (2) scenarios were evaluated to determine which scenario results in the highest ambient impacts at the point of compliance. The scenarios assume emissions will either be vented 1) at ground level or 2) to a new exhaust point located at the ICDF. The scenario assuming a ground-level exhaust point at ICDF in the highest potential ambient concentration impacts at the point of compliance. The maximum 1-hour concentration for a 1 lb/hr release at the nearest receptor distance of 4,845 m was determined to be 8.40 ug/m^3. The maximum 1-hour concentration for a 1 lb/hr release at the nearest receptor distance of 12,716 m was determined to be 2.33 ug/m^3. One hour modeled ambient concentrations are converted to applicable averaging times by applying persistence factors as listed in the State of Idaho Air Quality Modeling Guideline, Doc. ID AQ-011 (rev. 1 12/31/02) and IDAPA 58.01.01.210.03.a.i.: 0.4 (24-hour avg.), 0.13 (quarterly avg.), 0.08 (annual avg.-criteria), and 0.125 (annual avg. - carcinogenic TAP). The modeled result (ug/m^3 per lb/hr) multiplied by the persistence factor is considered the SCREEN3 Unit Release Concentration.

SCENARIO 1.
GROUND LEVEL RELEASE

Note: Assumed a hypothetical ground level release for activities taking place at the PM-2A tank site.

1. Source type: Point
2. Emission rate = 0.126 g/s (1 lb/hr)
3. Stack height = 0.0
4. Stack inside diameter = 0.274 m
5. Stack gas exit velocity = 0.003 m/s
6. Stack gas exit temperature = 293 deg. K
7. Ambient air temperature = 293 deg K (Default)
8. Receptor height = 0 .0
9. Urban/Rural Option = Rural
10. Terrain = Flat
11. No building downwash. Various nearby building sizes were test run and resulted in a decrease in concentration at the receptor. Thus in this case, no building downwash is a conservative model parameter.
12. Nearest receptor = 4,845 m and 12,716 m

SCENARIO 2.
STACK PARAMETERS USING PROPOSED STACK:

Note: Hypothetical stack parameters were provided by D. L. Eaton.

1. Source type: Point
2. Emission rate = 0.126 g/s (1 lb/hr)
3. Stack height = 12 ft
4. Stack inside diameter = 0.274 m
5. Stack gas volumetric air flow = 2000 cfm
6. Stack gas exit temperature = 293 deg. K
7. Ambient air temperature = 293 deg K (Default)
8. Receptor height = 0 .0
9. Urban/Rural Option = Rural
10. Terrain = Flat
11. No building downwash; no building downwash is a conservative model parameter.
12. Nearest receptor = 4,845 m and 12,716m

AIR PERMITTING APPLICABILITY DETERMINATION

Table A-1. Potential emissions of non-carcinogenic toxic air pollutants (TAPs) compared to IDAPA 58.01.01.585 screening emission levels.

Constituent	Maximum Waste Concentration[a] (mg/kg)	Waste Inventory[b] (lb/yr)	Maximum Hourly Emission Rate[c] (lb/hr)	Maximum Annual Emission Rate[d] (ton/yr)	Screening Emission Level[e] (lb/hr)	< Screening Emission Level[f] YES/NO	Potential Ambient Concentration[h] (ug/m3)	AAC Limit[i] (ug/m3)	< AAC Limit[j] YES/NO
Aluminum	5.43E+03	5.50E+02	2.29E-03	2.75E-04	0.133	YES	7.69E-03	100	YES
Barium	91	9.21E+00	3.84E-05	4.60E-06	0.033	YES	1.29E-04	25	YES
Boron	8.17E+02	8.27E+01	3.45E-04	4.13E-05	0.667	YES	1.16E-03	500	YES
Cobalt	6.55	6.63E-01	2.76E-06	3.31E-07	0.0033	YES	9.28E-06	2.5	YES
Copper	68.9	6.97E+00	2.91E-05	3.49E-06	0.013	YES	9.76E-05	10	YES
Iron	12700	1.29E+03	5.36E-03	6.43E-04	0.333	YES	1.80E-02	250	YES
Magnesium	6600	6.68E+02	2.78E-03	3.34E-04	0.667	YES	9.35E-03	500	YES
Manganese	4130	4.18E+02	1.74E-03	2.09E-04	0.067	YES	5.85E-03	50	YES
Mercury	29.6	3.00E+00	1.25E-02	1.50E-06	0.001	NO	4.19E-02	0.5	YES
Naphthalene	0.0995	1.01E-02	1.01E-02	5.03E-06	3.33	YES	3.38E-02	2500	YES
Pentachlorophenol	4.65	4.71E-01	4.71E-01	2.35E-04	0.033	NO	1.58E+00	25	YES
Silver	59.3	6.00E+00	2.50E-05	3.00E-06	0.001	YES	8.40E-05	5	YES
Tributyl phosphate	20.7	2.09E+00	2.09E+00	1.05E-03	0.147	NO	7.04E+00	110	YES
Trichloroethylene[g]	0.775	7.84E-02	7.84E-02	3.92E-05	17.93	YES	2.64E-01	13450	YES
Vanadium	16.6	1.68E+00	7.00E-06	8.40E-07	0.003	YES	2.35E-05	2.5	YES
Xylene (o-, m-, p-isomers)	0.123	1.24E-02	1.24E-02	6.22E-06	29	YES	4.18E-02	0.5	YES
Zinc	3360	3.40E+02	1.42E-03	1.70E-04	0.067	YES	4.76E-03	50	YES
The following constituents are not listed as IDAPA toxic air pollutants.									
Lead	280	2.83E+01	1.18E-01	1.42E-02	NA				
2-methylnaphthalene	0.326	3.30E-02	3.30E-02	1.65E-05	NA				
4-Bromophenyl phenyl ether	0.223	2.26E-02	2.26E-02	1.13E-05	NA				
Sodium	11600	1.17E+03	4.89E+00	5.87E-04	NA				
Potassium	6880	6.96E+02	2.90E+00	3.48E-04	NA				
		Total	1.07E+01	1.81E-02					

a. Maximum radionuclide activity taken from EDF-4830 , Waste Generator Services Closure Report for the Contents of the PM-2A Tanks (TSF-26), Table 3, Analytical results for Tank V-14 with the highest activity found in any one sample assumed to represent worst case activity of the entire waste contents.

b. The waste inventory is calculated as follows:
Waste Inventory (lb/yr) = [Maximum Concentration (mg/kg)] x (46,000 lb/yr) x (1 kg/1E6 mg).

c. Maximum hourly emission rate is calculated as follows: Maximum Hourly Emission Rate (lb/hr) = [Waste Inventory (lb/yr)]/[Duration of release (1 hr or 240 hr)/yr] x [Release Fraction (0.001 or 1)].
Duration of release is conservatively assumed to occur in a one 1 hr period for volatile organics and uniformly released over a 240 hr time period for non-volatile species.

d. Maximum annual emission rate (ton/yr) is calculated as follows: Maximum Annual Emission Rate (ton/yr) = [Waste Inventory (lb/yr)] x [Release Fraction (0.001 or 1)] x (1 ton/2000 lb).

e. Non-carcinogenic TAP screening emission level as listed in IDAPA 58.01.01.585.

f. Excel decision matrix - If the TAP emission rate is less than the IDAPA screening emission level then the value equals "Yes", otherwise "No".

g. TAP is also listed as a carcinogenic TAP (see Table A-2).

h. SCREEN3 maximum unit concentration was estimated by modeling ambient concentration 4,845 m distant from ICDF, at Hwy 20.
The maximum 1-hour concentration for a 1 lb/hr release at the nearest receptor distance of 4,845 m is 8.4 ug/m^3 per lb/hr.
One hour ambient concentrations are converted to various averaging times by applying persistence factors as listed in the State of Idaho Air Quality Modeling Guideline, Doc. ID AQ-011 (rev. 1 12/31/02) and IDAPA 58.01.01.210.03.a.i. as follows: 0.4 (24-hr average) to determine the SCREEN maximum unit concentrations.
SCREEN3 Unit Release Concentration = 3.360 ug/m^3 per lb/hr.
Potential Ambient Concentration (ug/m^3) = [SCREEN3 Unit Release Concentration (ug/m3 per lb/hr)] x [Maximum Hourly Emission Rate (lb/hr)].

i. Acceptable ambient concentration for non-carcinogenic TAPs (AAC) as listed in IDAPA 58.01.01.585.

j. Excel decision matrix - If the potential ambient concentration is less than the IDAPA AAC then the value equals "Yes", otherwise "No".

Table A-2. Potential emissions of carcinogenic toxic air pollutants (TAPs) compared to IDAPA 58.01.01.586 screening emission levels.

Substance	Maximum Waste Concentration[a] (mg/kg)	Waste Inventory[b] (lb/yr)	Maximum Hourly Emission Rate[c] (lb/hr)	Maximum Annual Emission Rate[d] (ton/yr)	Screening Emission Level[e] (lb/hr)	< Screening Emission Level[f] YES/NO	Potential Ambient Concentration[h] (ug/m3)	AACC Limit[i] (ug/m3)	< AACC Limit[j] YES/NO
Aroclor (PCB)	6.7	6.78E-01	2.83E-03	3.39E-04	6.60E-05	NO	2.25E-05	1.00E-02	YES
Arsenic	29.9	3.03E+00	1.26E-05	1.51E-06	1.50E-06	NO	1.01E-07	2.30E-04	YES
Beryllium	18.8	1.90E+00	7.93E-06	9.51E-07	2.80E-05	YES	6.32E-08	4.20E-03	YES
Cadmium	44.8	4.53E+00	1.89E-05	2.27E-06	3.70E-06	NO	1.51E-07	5.60E-04	YES
Chromium (VI)	1110	1.12E+02	4.68E-04	5.62E-05	5.60E-07	NO	3.73E-06	8.30E-05	YES
Nickel	144	1.46E+01	6.07E-05	7.29E-06	2.70E-05	NO	4.84E-07	4.20E-03	YES
Polyaromatic Hydrocarbons (PAH)	2.975	3.01E-01	1.25E-03	1.51E-04	9.10E-05	NO	1.00E-05	1.40E-02	YES
Polycyclic Organic Matter (POM)	1.988	2.01E-01	8.38E-04	1.01E-04	2.00E-06	NO	6.68E-06	3.00E-04	YES
Tetrachloroethylene	136	1.38E+01	5.73E-02	6.88E-03	1.30E-02	NO	4.57E-04	2.10E+00	YES
Trichloroethylene[g]	0.775	7.84E-02	3.27E-04	3.92E-05	5.10E-04	YES	2.61E-06	7.70E-02	YES
2,4,6 - Trichlorophenol	0.559	5.66E-02	2.36E-04	2.83E-05	1.20E-03	YES	1.88E-06	1.80E-01	YES
		Total	6.34E-02	7.61E-03					

a. Maximum radionuclide activity taken from EDF-4830, Waste Generator Services Closure Report for the Contents of the PM-2A Tanks (TSF-26), Table 3, Analytical results for Tank V-14 with the highest activity found in any one sample assumed to represent worst case activity of the entire waste contents.

b. The waste inventory is calculated as follows:
Waste Inventory (lb/yr) = [Maximum Concentration (mg/kg)] x (46,000 lb/yr) x (1 kg/1E6 mg).

c. Maximum hourly emission rate is calculated as follows: Maximum Hourly Emission Rate (lb/hr) = [Waste Inventory (lb/yr)]/[Duration of release (1 hr or 240 hr)/yr] x [Release Fraction (0.001 or 1)]. Duration of release is conservatively assumed to occur in a one 1 hr period for volatile organics and uniformly released over a 240 hr time period for non-volatile species.

d. Maximum annual emission rate (ton/yr) is calculated as follows: Maximum Annual Emission Rate (ton/yr) = [Waste Inventory (lb)] x [Release Fraction (0.001 or 1)] x (1 ton/2000 lb).

e. Carcinogenic TAP screening emission level as listed in IDAPA 58.01.01.586.

f. Excel decision matrix - If the TAP emission rate is less than the IDAPA screening emission level then the value equals "Yes", otherwise "No".

g. TAP is also listed as a non-carcinogenic TAP (see Table A-1).

h. SCREEN3 maximum unit concentration was estimated by modeling ambient concentration 12,716 m distant from ICDF, at the INEEL site boundary.
The maximum 1-hour concentration for a 1 lb/hr release at the nearest receptor distance of 12,716 is 2.33 ug/m3 per lb/hr.
One hour ambient concentrations are converted to various averaging times by applying persistence factors as listed in the State of Idaho Air Quality Modeling Guideline, Doc. ID AQ-011 (rev. 1 12/31/02) and IDAPA 58.01.01.210.03.a.i. as follows: 0.125 (carcinogenic TAPs annual average) to determine the SCREEN maximum unit concentrations.
SCREEN3 Unit Release Concentration = 0.291 ug/m^3 per lb/hr.
The potential ambient concentration for carcinogenic TAPs is calculated based on an annual average emission rate.
The annual average emission rate (lb/hr) is calculated as follows: Annual average emission rate (lb/hr) = [Waste Inventory (lb/yr)]/[8760 hr/yr] x [Release Fraction (0.001 or 1)].
Potential Ambient Concentration (ug/m^3) = [SCREEN3 Unit Release Concentration (ug/m3 per lb/hr)] x [Annual Average Emission Rate (lb/hr)].

Table A-3. Potential radionuclide emissions and resulting effective dose equivalent.

Radionuclide	Maximum Radionuclide Activity[a] (pCi/g)	Radionuclide Inventory[b] (Ci/yr)	Uncontrolled Radionuclide Release[c] (Ci/yr)	Unit Curie Dose[d] (mrem/Ci)	Uncontrolled EDE[e] (mrem/yr)
Am-241	1.30E+02	1.32E-02	1.32E-05	4.70E+00	6.18E-05
C-14	1.39E+01	1.41E-03	1.41E-06	6.34E-04	8.92E-10
Cm-243	1.09E+01	1.10E-03	1.10E-06	3.14E+00	3.46E-06
Cm-244	1.09E+01	1.10E-03	1.10E-06	2.47E+00	2.72E-06
Co-60	6.16E+03	6.23E-01	6.23E-04	5.71E-02	3.56E-05
Cs-137	1.39E+06	1.41E+02	1.41E-01	5.80E-02	8.16E-03
Fe-55	1.04E+02	1.05E-02	1.05E-05	1.24E-04	1.31E-09
H-3	9.24E+02	9.35E-02	9.35E-02	1.14E-05	1.07E-06
Ni-59	2.29E+03	2.32E-01	2.32E-04	1.07E-04	2.48E-08
Ni-63	2.41E+05	2.44E+01	2.44E-02	8.62E-03	2.10E-04
Np-237	1.07E-01	1.08E-05	1.08E-08	4.29E+00	4.65E-08
Pu-238	5.45E+02	5.52E-02	5.52E-05	2.83E+00	1.56E-04
Pu-239	4.90E+02	4.96E-02	4.96E-05	3.06E+00	1.52E-04
Pu-240	4.92E+02	4.98E-02	4.98E-05	3.06E+00	1.52E-04
Pu-241	6.20E+02	6.27E-02	6.27E-05	2.03E-01	1.27E-05
Sr-90	1.16E+06	1.17E+02	1.17E-01	3.94E-02	4.62E-03
Tc-99	1.56E+02	1.58E-02	1.58E-05	8.12E-03	1.28E-07
U-233	3.04E+00	3.08E-04	3.08E-07	1.18E+00	3.63E-07
U-234	1.01E+03	1.02E-01	1.02E-04	1.15E+00	1.18E-04
U-235	3.38E+01	3.42E-03	3.42E-06	1.09E+00	3.73E-06
U-236	6.52E+00	6.60E-04	6.60E-07	1.09E+00	7.19E-07
U-238	1.21E+01	1.22E-03	1.22E-06	1.02E+00	1.25E-06
				Total	1.37E-02

a. Maximum radionuclide activity taken from EDF-4830, Waste Generator Services Closure Report for the Contents of the PM-2A Tanks (TSF-26), Table 3, analytical results for Tank V-14 with the highest activity found in any one sample assumed to represent worst case activity of the entire waste contents.

b. The radionuclide inventory is calculated as follows:
Radionuclide Inventory (Ci/yr) = [Maximum Radionuclide Activity (pCi/g)] x (46,000 lb/yr) x (454 g/lb) x (1 Ci/1E12 pCi).

c. The uncontrolled radionuclide release is determined using a release fraction of 0.001 for particulate radionuclides, or 1 for gaseous/volatile radionuclides H-3), as follows: Uncontrolled Radionuclide Release (Ci) = [Radionuclide Inventory (Ci/yr)] x [Release Fraction (0.001 or 1)].

d. Unit curie dose conversions as provided for point releases for the calendar year 2004. The value represents the EDE to the MEI at Frenchman's cabin that would result from the release of one curie (each nuclide).

e. Uncontrolled EDE is calculated as follows:
EDE (mrem/yr) = [Maximum Uncontrolled Radionuclide Release (Ci/yr)] x [Unit Curie Dose (mrem/Ci)].

Table A-4. Potential emissions of criteria air pollutants compared to IDAPA 58.01.01.006.93 significant emission levels.

Air Pollutant	Maximum Hourly Emission Rate[a] (lb/hr)	Maximum Annual Emission Rate[b] (ton/yr)		Significant Emission Level[c] (ton/yr)	< Significant Emission Level[d] YES/NO
PM[e]	1.07E+01	2.58E-02		25	YES
Ozone (as VOCs)[f]	2.73E+00	8.87E-03		40	YES
Lead (elemental)	1.18E-01	1.42E-02		0.6	YES
Beryllium	7.93E-06	9.51E-07		0.0004	YES
Mercury	1.25E-02	1.50E-06		0.1	YES
PM-10[g]	1.07E+01	2.58E-02		15	YES
Radionuclides		1.61E-02	mrem	0.1 mrem	YES

a. Maximum hourly emission rate(s) taken from Tables A-1, A-2, and A-3.
b. Maximum annual emission rate(s) taken from Tables A-1, A-2, and A-3.
c. Significant emission level as listed in IDAPA 58.01.01.006.93.
d. Excel decision matrix - If the maximum annual emission rate is less than the significant emission level then the value equals "Yes", otherwise "No".
e. Total TAP constituents released are assumed to be released as particulate matter (PM).
f. Emissions of volatile and semi-volatile organic compounds as determined from analytical data are summed to determine total VOC emission rate.
g. All particulate matter (PM) is assumed to PM with aerodynamic diameter less than 10 um (PM-10).

Table A-5. Potential ambient concentrations compared to IDAPA 58.01.01.577 ambient air quality standards.

Pollutant (Averaging Time)	Average Emission Rate[a] (lb/hr)	SCREEN3 Unit Release Concentration[b] (ug/m^3 per lb/hr)	Source Contribution[c] (ug/m^3)	INEEL Site Background Concentration[d] (ug/m^3)	Background + Source Contribution (ug/m^3)	Ambient Air Quality Standard[e] (ug/m^3)
PM-10 (Annual)	2.45E+00	0.67	1.64E+00	32.7	34.3	50
PM-10 (24-Hour)	2.45E+00	3.36	8.23E+00	86	94.2	150
Lead (Quarterly)	1.18E-01	1.09	1.29E-01	0.15	0.3	1.5

a. Annual average emission rate (lb/hr) is averaged over one year using results from Table A-3, as follows:
Average Emission Rate (lb/hr) = [Maximum Annual Emission Rate (ton/yr)] x (1 yr/8760 hrs) x [2000 lb/1 ton].
Short-term average emission rate (24-hr and quarterly) is assumed equivalent to the maximum hourly emission rate from Table A-4.
b. SCREEN3 maximum unit concentration was estimated by modeling ambient concentration 4,845 m distant from ICDF, at Hwy 20.
The maximum 1-hour concentration for a 1 lb/hr release at the nearest receptor distance of 4,845 m: 2.03 ug/m^3 per lb/hr.
One hour ambient concentrations are converted to various averaging times by applying persistence factors as listed in the State of Idaho Air Quality Modeling Guideline, Doc. ID AQ-011 (rev. 1 12/31/02) and IDAPA 58.01.01.210.03.a.i. as follows: 0.4 (24-hour avg.), 0.13 (quarterly avg.) and 0.08 (annual avg.) to determine the SCREEN maximum unit concentrations.
c. The source contribution is calculated as follows:
Source Contribution (ug/m^3)= [Average Emission Rate (lb/hr)] x [SCREEN3 Unit Release Concentration (ug/m3 per lb/hr)].
d. Ambient background concentrations taken from correspondence from Darrin Mehr, Associate Air Quality Engineer, Idaho Department of Environmental Quality, November 8, 2001. The highest background concentration is used in this analysis.
e. Ambient air quality standard as listed in IDAPA 58.01.01.577.

```
1INEL IMPLEMENTATION OF THE CAP88 COMPUTER CODE SYSTEM

 THE DATE AND TIME ARE:  Mon Nov 29 19:38:34 UTC 2004
 USER NAME:  Name Tty Chris Staley pts/0 Chris Staley ftpd2
 USER ID:    cst
 THE UNIX ABSOLUTE PATH FOR THIS RUN IS:  /home/cst/04neshunit/intec


 THE FILES USED BY THIS RUN ARE:

                         Owner-Id   Date   Time  File Name
                         --------   ----   ----  ---------
     CAP88 OUTPUT FILE:    cst      Nov 29 19:38  /home/cst/04neshunit/intec/cpp2.cap

           PREPAR FILE:    cst      Nov 29 19:35  /home/cst/04neshunit/intec/cpp2.dat
           DARTAB FILE:    cst      Nov 23 23:31 inddar.dat

             WIND FILE:    pdr      Nov 11 01:29 /home/pdr/wind/9403wind/gril9403.str
             FARM FILE:    pdr      Mar  8  1995 /home/pdr/cary_smith_cap88/farm/cowveg2.dat
       POPULATION FILE:    pdr      Mar  8  1995 /home/pdr/cary_smith_cap88/pop/nrf.90

      ALLRAD DATA BASE:    pdr      Feb  3  2004 /home/pdr/cary_smith_cap88/radrisk/allrad88.dat
     RADRISK DATA BASE:    pdr      Feb  3  2004 /home/pdr/cary_smith_cap88/radrisk/rad.new



 PREPARED BY: ______________________________________________________ DATE: _______________



 REVIEWED BY: ______________________________________________________ DATE: _______________

1
  ALLRAD FILE     ===> ALLRAD88 CONTAINS THE DCFs
  POP FILE        ===> CONTAINS THE POPULATION GRID (POP RUNS ONLY)
1
                 SYNOPSIS REPORT - CAP-88 (1.00)

 ID Code:                             Date/Time: Mon Nov 29 19:38:33 2004

 FACILITY: IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY
  ADDRESS: BECHTEL BWXT LLC GEOSCIENCES DEPARTMENT
     CITY: IDAHO FALLS
    State: ID     Zipcode: 83415-2107

 Source Category:  CPP - UNIT CI DOSE TO FRENCHMAN'S CABI  Source Term: 2004

 Comments:
 Ground-level release
 Unit Ci dose to Frenchman's cabin


                    INDIVIDUAL AT MAXIMUM RISK ASSESSEMENT
                               (RN-222 RISKS EXCLUDED)
                               -----------------------

 Location to the individual: 18718 METERS SOUTH SOUTHWEST
```

	GONADS	BREAST	R MAR	LUNGS	THYROID	ENDOST	RMNDR
ORGAN DOSE (MREM/YR):	8.7E+00	1.3E+00	5.3E+01	1.5E+01	1.2E+00	6.5E+02	2.9E+01

ICRP Effective Dose Equivalent (mrem/yr): 3.90E+01
Lifetime Fatal Cancer Risk : 2.30E-04

Stack #1

SOURCE TERM (2004)

Nuclide	Class	Amad	Stack #1 Ci/yr	TOTAL
CE-141	Y	1.00	1.00E+00	1.00E+00
CE-143	Y	1.00	1.00E+00	1.00E+00
CE-144	Y	1.00	1.00E+00	1.00E+00
CF-252	Y	1.00	1.00E+00	1.00E+00
CL-36		0.00	1.00E+00	1.00E+00
CM-242	W	1.00	1.00E+00	1.00E+00
CM-243	W	1.00	1.00E+00	1.00E+00
CM-244	W	1.00	1.00E+00	1.00E+00
CM-245	W	1.00	1.00E+00	1.00E+00
CM-246	W	1.00	1.00E+00	1.00E+00
CM-247	W	1.00	1.00E+00	1.00E+00
CM-248	W	1.00	1.00E+00	1.00E+00
CO-57	Y	1.00	1.00E+00	1.00E+00
CO-58	Y	1.00	1.00E+00	1.00E+00
CO-60	Y	1.00	1.00E+00	1.00E+00
CR-51	Y	1.00	1.00E+00	1.00E+00
CS-134	D	1.00	1.00E+00	1.00E+00
CS-134M	D	1.00	1.00E+00	1.00E+00
CS-135	D	1.00	1.00E+00	1.00E+00
CS-136	D	1.00	1.00E+00	1.00E+00
CS-137	D	1.00	1.00E+00	1.00E+00
BA-137M	D	1.00	9.50E-01	9.50E-01
CS-138	D	1.00	1.00E+00	1.00E+00
CS-139		0.00	1.00E+00	1.00E+00
CU-64	Y	1.00	1.00E+00	1.00E+00
EU-152	W	1.00	1.00E+00	1.00E+00
EU-152M		0.00	1.00E+00	1.00E+00
EU-154	W	1.00	1.00E+00	1.00E+00
EU-155	W	1.00	1.00E+00	1.00E+00
EU-156	W	1.00	1.00E+00	1.00E+00
F-18	D	1.00	1.00E+00	1.00E+00
FE-55	W	1.00	1.00E+00	1.00E+00
FE-59	W	1.00	1.00E+00	1.00E+00
FR-221	D	1.00	1.00E+00	1.00E+00
FR-223	D	1.00	1.00E+00	1.00E+00

SITE INFORMATION

Temperature: 6 C
Rainfall: 21 cm/yr
Mixing Height: 800 meters

EMISSION INFORMATION

Stack Number:	1
STACK HEIGHT (METERS) :	0.00
STACK DIAMETER (METERS):	0.00
PLUME RISE	
MOMENTUM (M/SEC) :	0.00E+00

FOOD SUPPLY FRACTIONS

	LOCAL	REGIONAL	IMPORTED
Vegetable:	0.700	0.300	0.000
Meat:	0.442	0.558	0.000
Milk:	0.399	0.601	0.000

FOOD ARRAYS WERE NOT GENERATED OR SUPPLIED FOR THIS RUN . DEFAULT VALUES USED.

DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

18718

1 DATE Mon Nov 29 19:38:33 2004

0INDEX	NAME	ISOL CLASS	LAMSUR 1/D	UPTAKE F1ING	AMAD MICRONS
1	CE-141	Y	5.48E-05	0.00	1.00
2	CE-143	Y	5.48E-05	0.00	1.00
3	CE-144	Y	5.48E-05	0.00	1.00
4	CF-252	Y	5.48E-05	0.00	1.00
5	CL-36		0.00E+00	0.00	0.00
6	CM-242	W	5.48E-05	0.00	1.00
7	CM-243	W	5.48E-05	0.00	1.00
8	CM-244	W	5.48E-05	0.00	1.00
9	CM-245	W	5.48E-05	0.00	1.00
10	CM-246	W	5.48E-05	0.00	1.00
11	CM-247	W	5.48E-05	0.00	1.00
12	CM-248	W	5.48E-05	0.00	1.00
13	CO-57	Y	5.48E-05	0.30	1.00
14	CO-58	Y	5.48E-05	0.30	1.00
15	CO-60	Y	5.48E-05	0.30	1.00
16	CR-51	Y	5.48E-05	0.10	1.00
17	CS-134	D	5.48E-05	0.95	1.00
18	CS-134M	D	5.48E-05	0.95	1.00
19	CS-135	D	5.48E-05	0.95	1.00
20	CS-136	D	5.48E-05	0.95	1.00
21	CS-137	D	5.48E-05	0.95	1.00
22	BA-137M	D	5.48E-05	0.10	1.00
23	CS-138	D	5.48E-05	0.95	1.00
24	CS-139		5.48E-05	0.00	0.00
25	CU-64	Y	5.48E-05	0.50	1.00
26	EU-152	W	5.48E-05	0.00	1.00
27	EU-152M		5.48E-05	0.00	0.00
28	EU-154	W	5.48E-05	0.00	1.00
29	EU-155	W	5.48E-05	0.00	1.00
30	EU-156	W	5.48E-05	0.00	1.00
31	F-18	D	5.48E-05	0.95	1.00
32	FE-55	W	5.48E-05	0.10	1.00
33	FE-59	W	5.48E-05	0.10	1.00
34	FR-221	D	5.48E-05	0.95	1.00
35	FR-223	D	5.48E-05	0.95	1.00

INDEX	NAME	SC 1/S	VD M/S	VG M/S	ANLAM 1/D
1	CE-141	2.08E-06	1.80E-03	3.55E-05	2.13E-02
2	CE-143	2.08E-06	1.80E-03	3.55E-05	5.04E-01
3	CE-144	2.08E-06	1.80E-03	3.55E-05	2.44E-03
4	CF-252	2.08E-06	1.80E-03	3.55E-05	7.19E-04
5	CL-36	2.08E-06	1.80E-03	0.00E+00	0.00E+00
6	CM-242	2.08E-06	1.80E-03	3.55E-05	4.25E-03
7	CM-243	2.08E-06	1.80E-03	3.55E-05	6.66E-05
8	CM-244	2.08E-06	1.80E-03	3.55E-05	1.05E-04
9	CM-245	2.08E-06	1.80E-03	3.55E-05	2.23E-07
10	CM-246	2.08E-06	1.80E-03	3.55E-05	3.99E-07
11	CM-247	2.08E-06	1.80E-03	3.55E-05	1.22E-10
12	CM-248	2.08E-06	1.80E-03	3.55E-05	5.60E-09
13	CO-57	2.08E-06	1.80E-03	3.55E-05	2.56E-03
14	CO-58	2.08E-06	1.80E-03	3.55E-05	9.79E-03
15	CO-60	2.08E-06	1.80E-03	3.55E-05	3.60E-04
16	CR-51	2.08E-06	1.80E-03	3.55E-05	2.50E-02
17	CS-134	2.08E-06	1.80E-03	3.55E-05	9.20E-04
18	CS-134M	2.08E-06	1.80E-03	3.55E-05	5.74E+00
19	CS-135	2.08E-06	1.80E-03	3.55E-05	8.25E-10
20	CS-136	2.08E-06	1.80E-03	3.55E-05	5.27E-02
21	CS-137	2.08E-06	1.80E-03	3.55E-05	6.29E-05
22	BA-137M	2.08E-06	1.80E-03	3.55E-05	6.29E-05
23	CS-138	2.08E-06	1.80E-03	3.55E-05	3.10E+01
24	CS-139	2.08E-06	1.80E-03	0.00E+00	1.06E+02
25	CU-64	2.08E-06	1.80E-03	3.55E-05	1.31E+00
26	EU-152	2.08E-06	1.80E-03	3.55E-05	1.40E-04
27	EU-152M	2.08E-06	1.80E-03	0.00E+00	1.78E+00
28	EU-154	2.08E-06	1.80E-03	3.55E-05	2.16E-04
29	EU-155	2.08E-06	1.80E-03	3.55E-05	3.83E-04
30	EU-156	2.08E-06	1.80E-03	3.55E-05	4.56E-02
31	F-18	2.08E-06	1.80E-03	3.55E-05	9.09E+00
32	FE-55	2.08E-06	1.80E-03	3.55E-05	7.03E-04
33	FE-59	2.08E-06	1.80E-03	3.55E-05	1.55E-02
34	FR-221	2.08E-06	1.80E-03	3.55E-05	2.08E+02
35	FR-223	2.08E-06	1.80E-03	3.55E-05	4.58E+01

0 ***NOTE: VG SET TO ZERO FOR AIRDOS UNLESS GREATER THAN 1.000E-02
0 ***NOTE: ANLAM SET TO ZERO FOR AIRDOS UNLESS GREATER THAN 1.000E-02
1 INEL MAXIMUM INDIVIDUAL DARTAB OUTPUT TABLES
INDIVIDUAL DOSE EQ. RATE(MREM/YEAR)

0***FOR ORGAN :EFFEC

NUCLIDES	CE-141	CE-143	CE-144	CF-252	CL-36	CM-242	CM-243	CM-244	CM-245	CM-246
	CM-247	CM-248	CO-57	CO-58	CO-60	CR-51	CS-134	CS-134M	CS-135	CS-136
	CS-137	**BA-137M**	CS-138	CS-139	CU-64	EU-152	EU-152M	EU-154	EU-155	EU-156
	F-18	FE-55	FE-59	FR-221	FR-223	TOTAL				
PATHWAYS										
INGESTION	1.19E-04	3.83E-08	1.47E-03	6.76E-02	0.00E+00	7.53E-03	2.08E-01	1.63E-01	3.23E-01	3.20E-01
	2.93E-01	1.18E+00	1.97E-04	3.79E-04	5.24E-03	6.29E-06	1.62E-02	4.30E-14	2.26E-03	3.21E-04
	1.34E-02	2.03E-07	6.98E-37	0.00E+00	3.54E-09	6.70E-04	0.00E+00	9.74E-04	1.53E-04	2.22E-04
	9.11E-18	1.11E-04	5.00E-04	3.05-194	6.91E-49	2.61E+00				
% OF INTERNAL	6.18E+01	1.35E-01	3.27E+01	5.15E+00	0.00E+00	4.96E+00	6.64E+00	6.61E+00	6.69E+00	6.69E+00
	6.69E+00	6.71E+00	7.29E+01	8.11E+01	7.49E+01	6.97E+01	9.78E+01	2.07E-05	9.84E+01	8.46E+01
	9.82E+01	9.59E+01	6.37E-28	0.00E+00	1.41E-01	2.71E+01	0.00E+00	2.96E+01	3.13E+01	6.52E+01
	2.93E-09	9.11E+01	8.34E+01	1.19-183	6.30E-41	6.73E+00				
% OF ALL PATHWAYS	5.18E+01	1.11E-01	3.22E+01	5.15E+00	0.00E+00	4.96E+00	6.62E+00	6.61E+00	6.67E+00	6.69E+00
	6.62E+00	6.71E+00	2.60E+01	2.73E+01	9.19E+00	2.93E+01	5.17E+01	1.49E-05	9.84E+01	4.21E+01
	9.82E+01	4.58E-04	4.60E-29	0.00E+00	7.87E-02	1.22E+00	0.00E+00	2.21E+00	7.93E+00	3.71E+01
	3.26E-10	8.92E+01	4.01E+01	1.19-183	6.23E-41	6.68E+00				
INHALATION	7.36E-05	2.83E-05	3.02E-03	1.25E+00	0.00E+00	1.44E-01	2.92E+00	2.31E+00	4.51E+00	4.46E+00
	4.09E+00	1.64E+01	7.31E-05	8.84E-05	1.76E-03	2.74E-06	3.63E-04	2.08E-07	3.76E-05	5.82E-05
	2.49E-04	8.60E-09	1.10E-07	0.00E+00	2.51E-06	1.80E-03	0.00E+00	2.32E-03	3.36E-04	1.18E-04
	3.11E-07	1.08E-05	9.93E-05	2.56E-09	1.10E-06	3.61E+01				
% OF INTERNAL	3.82E+01	9.99E+01	6.73E+01	9.49E+01	0.00E+00	9.50E+01	9.34E+01	9.34E+01	9.33E+01	9.33E+01
	9.33E+01	9.33E+01	2.71E+01	1.89E+01	2.51E+01	3.03E+01	2.20E+00	1.00E+02	1.63E+00	1.54E+01
	1.82E+00	4.06E+00	1.00E+02	0.00E+00	9.99E+01	7.29E+01	0.00E+00	7.04E+01	6.87E+01	3.48E+01
	1.00E+02	8.88E+00	1.66E+01	1.00E+02	1.00E+02	9.33E+01				
% OF ALL PATHWAYS	3.20E+01	8.22E+01	6.61E+01	9.49E+01	0.00E+00	9.50E+01	9.30E+01	9.34E+01	9.31E+01	9.33E+01
	9.23E+01	9.33E+01	9.64E+00	6.38E+00	3.08E+00	1.28E+01	1.16E+00	7.20E+01	1.63E+00	7.65E+00
	1.82E+00	1.94E-05	7.22E+00	0.00E+00	5.58E+01	3.29E+00	0.00E+00	5.26E+00	1.74E+01	1.98E+01
	1.11E+01	8.69E+00	7.95E+00	9.96E+01	9.89E+01	9.26E+01				
AIR IMMERSION	3.76E-07	1.23E-06	8.84E-08	3.70E-10	4.24E-14	4.85E-10	6.23E-07	4.13E-10	3.46E-07	3.48E-10
	1.57E-06	3.04E-10	6.17E-07	5.03E-06	1.29E-05	1.56E-07	7.97E-06	5.61E-08	0.00E+00	1.12E-05
	0.00E+00	2.89E-06	1.34E-06	5.68E-09	8.14E-07	5.87E-06	1.32E-06	6.46E-06	2.77E-07	7.31E-06
	2.05E-06	1.15E-10	6.15E-06	1.08E-11	1.11E-08	7.67E-05				
% OF EXTERNAL	1.01E+00	2.02E+01	1.14E-01	4.96E-03	2.71E-04	2.45E-02	5.85E-03	8.73E-04	2.89E-03	3.31E-04
	3.26E-03	3.59E-04	1.26E-01	5.47E-01	2.58E-02	1.25E+00	5.40E-02	6.91E+01	0.00E+00	2.93E+00
	0.00E+00	6.53E-03	9.51E+01	9.86E+01	4.10E+01	1.12E-02	5.00E+01	1.59E-02	1.91E-02	2.84E+00
	8.26E+01	4.29E-03	9.47E-01	9.90E+01	9.50E+01	2.76E-02				
% OF ALL PATHWAYS	1.63E-01	3.58E+00	1.94E-03	2.81E-08	2.71E-04	3.19E-07	1.98E-05	1.67E-08	7.14E-06	7.28E-09
	3.54E-05	1.73E-09	8.13E-02	3.63E-01	2.26E-02	7.26E-01	2.55E-02	1.94E+01	0.00E+00	1.47E+00

	0.00E+00	6.53E-03	8.82E+01	9.86E+01	1.81E+01	1.07E-02	5.00E+01	1.47E-02	1.43E-02	1.22E+00
	7.34E+01	9.25E-05	4.93E-01	4.21E-01	1.00E+00	1.97E-04				
GROUND SURFACE	3.67E-05	4.85E-06	7.72E-05	7.46E-06	1.56E-08	1.98E-06	1.06E-02	4.74E-05	1.20E-02	1.05E-04
	4.81E-02	8.47E-05	4.88E-04	9.14E-04	5.00E-02	1.23E-05	1.48E-02	2.51E-08	0.00E+00	3.71E-04
	0.00E+00	4.43E-02	6.90E-08	8.23E-11	1.17E-06	5.23E-02	1.32E-06	4.08E-02	1.45E-03	2.51E-04
	4.33E-07	2.68E-06	6.43E-04	1.07E-13	5.89E-10	2.77E-01				
% OF EXTERNAL	9.90E+01	7.98E+01	9.99E+01	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
	1.00E+02	1.00E+02	9.99E+01	9.95E+01	1.00E+02	9.87E+01	9.99E+01	3.09E+01	0.00E+00	9.71E+01
	0.00E+00	1.00E+02	4.90E+00	1.43E+00	5.90E+01	1.00E+02	5.00E+01	1.00E+02	1.00E+02	9.72E+01
	1.74E+01	1.00E+02	9.91E+01	9.79E-01	5.04E+00	1.00E+02				
% OF ALL PATHWAYS	1.60E+01	1.41E+01	1.69E+00	5.68E-04	1.00E+02	1.30E-03	3.39E-01	1.92E-03	2.47E-01	2.20E-03
	1.08E+00	4.81E-04	6.43E+01	6.59E+01	8.77E+01	5.73E+01	4.71E+01	8.67E+00	0.00E+00	4.88E+01
	0.00E+00	1.00E+02	4.54E+00	1.43E+00	2.60E+01	9.55E+01	5.00E+01	9.25E+01	7.47E+01	4.19E+01
	1.55E+01	2.15E+00	5.15E+01	4.16E-03	5.32E-02	7.11E-01				
INTERNAL	1.93E-04	2.83E-05	4.48E-03	1.31E+00	0.00E+00	1.52E-01	3.13E+00	2.47E+00	4.83E+00	4.78E+00
	4.39E+00	1.76E+01	2.70E-04	4.67E-04	7.00E-03	9.03E-06	1.65E-02	2.08E-07	2.30E-03	3.79E-04
	1.37E-02	2.12E-07	1.10E-07	0.00E+00	2.51E-06	2.47E-03	0.00E+00	3.29E-03	4.90E-04	3.40E-04
	3.11E-07	1.22E-04	6.00E-04	2.56E-09	1.10E-06	3.87E+01				
% OF ALL PATHWAYS	8.39E+01	8.23E+01	9.83E+01	1.00E+02	0.00E+00	1.00E+02	9.97E+01	1.00E+02	9.98E+01	1.00E+02
	9.89E+01	1.00E+02	3.56E+01	3.37E+01	1.23E+01	4.20E+01	5.28E+01	7.20E+01	1.00E+02	4.98E+01
	1.00E+02	4.78E-04	7.22E+00	0.00E+00	5.59E+01	4.51E+00	0.00E+00	7.47E+00	2.53E+01	5.69E+01
	1.11E+01	9.78E+01	4.80E+01	9.96E+01	9.89E+01	9.93E+01				
EXTERNAL	3.71E-05	6.08E-06	7.73E-05	7.46E-06	1.56E-08	1.98E-06	1.06E-02	4.74E-05	1.20E-02	1.05E-04
	4.81E-02	8.47E-05	4.88E-04	9.19E-04	5.01E-02	1.25E-05	1.48E-02	8.12E-08	0.00E+00	3.82E-04
	0.00E+00	4.43E-02	1.41E-06	5.77E-09	1.98E-06	5.23E-02	2.65E-06	4.08E-02	1.45E-03	2.58E-04
	2.48E-06	2.68E-06	6.50E-04	1.09E-11	1.17E-08	2.77E-01				
% OF ALL PATHWAYS	1.61E+01	1.77E+01	1.70E+00	5.68E-04	1.00E+02	1.30E-03	3.39E-01	1.92E-03	2.47E-01	2.20E-03
	1.08E+00	4.81E-04	6.44E+01	6.63E+01	8.77E+01	5.80E+01	4.72E+01	2.80E+01	0.00E+00	5.02E+01
	0.00E+00	1.00E+02	9.28E+01	1.00E+02	4.41E+01	9.55E+01	1.00E+02	9.25E+01	7.47E+01	4.31E+01
	8.89E+01	2.15E+00	5.20E+01	4.25E-01	1.05E+00	7.11E-01				
TOTAL OVER ALL PATHWAYS	2.30E-04	3.44E-05	4.56E-03	1.31E+00	1.56E-08	1.52E-01	3.14E+00	2.47E+00	4.84E+00	4.78E+00
	4.43E+00	1.76E+01	7.58E-04	1.39E-03	5.71E-02	2.15E-05	3.13E-02	2.89E-07	2.30E-03	7.61E-04
	1.37E-02	**4.43E-02**	1.52E-06	5.77E-09	4.50E-06	5.47E-02	2.65E-06	4.41E-02	1.94E-03	5.98E-04
	2.79E-06	1.24E-04	1.25E-03	2.57E-09	1.11E-06	3.90E+01				

```
1PREPAR NAMELIST INPUT FILE

  C-SHELL SCRIPT  ===> HP.CSH RUNS THE CAP88 SYSTEM
  ALLRAD FILE     ===> ALLRAD88 CONTAINS THE DCFs
  POP FILE        ===> CONTAINS THE POPULATION GRID (POP RUNS ONLY)
  STARFILE        ===> INEEL MESONET DATA
  RADRISK FILE    ===> EPA
 *
 IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY
 BECHTEL BWXT LLC GEOSCIENCES DEPARTMENT
 IDAHO FALLS
 ID
 83415-2107
 CPP - UNIT CI DOSE TO FRENCHMAN'S CABIN
 2004
 OPTION
  &OPTI OPTION=0,1,0,1,0,0,0,1,0,LIST=1,LIPO=0,
   NUTB=0,NSTB=0,NNTB=0,NTTB=1,NRTB=0,TSUBB=100. &END
 GRID
  &GRID NOL=8,NOU=8,NRL=1,NRU=1,IDIST=18718 &END
 METEOROLOGICAL DATA
  &METE LID=800.0,RR=20.8,TA=279.,TG=7.28E-2,1.09E-1,1.455E-1,
   Z=10.,Z0=0.01,J0=0.001,DF=0.0 &END
 PHYSICAL STACK DATA
 1
  &PHYS PH=0.0, VEL=0.0, DIA=0.0 &END
 WIND FREQUENCY DATA
 STAR
 DEFAULT
 RADIONUCLIDE DATA
 35
  &RADI NUC='CE-141', REL=1.00E-0 &END
  &RADI NUC='CE-143', REL=1.00E-0 &END
  &RADI NUC='CE-144', REL=1.00E-0 &END
  &RADI NUC='CF-252', REL=1.00E-0 &END
  &RADI NUC='CL-36', REL=1.00E-0 &END
  &RADI NUC='CM-242', REL=1.00E-0 &END
  &RADI NUC='CM-243', REL=1.00E-0 &END
  &RADI NUC='CM-244', REL=1.00E-0 &END
  &RADI NUC='CM-245', REL=1.00E-0 &END
  &RADI NUC='CM-246', REL=1.00E-0 &END
  &RADI NUC='CM-247', REL=1.00E-0 &END
  &RADI NUC='CM-248', REL=1.00E-0 &END
  &RADI NUC='CO-57', REL=1.00E-0 &END
  &RADI NUC='CO-58', REL=1.00E-0 &END
  &RADI NUC='CO-60', REL=1.00E-0 &END
  &RADI NUC='CR-51', REL=1.00E-0 &END
  &RADI NUC='CS-134', REL=1.00E-0 &END
  &RADI NUC='CS-134M', REL=1.00E-0 &END
  &RADI NUC='CS-135', REL=1.00E-0 &END
  &RADI NUC='CS-136', REL=1.00E-0 &END
  &RADI NUC='CS-137', REL=1.00E-0 &END
  &RADI NUC='BA-137M', REL=9.50E-1, IAN=-1 &END
  &RADI NUC='CS-138', REL=1.00E-0 &END
  &RADI NUC='CS-139', REL=1.00E-0 &END
  &RADI NUC='CU-64', REL=1.00E-0 &END
  &RADI NUC='EU-152', REL=1.00E-0 &END
  &RADI NUC='EU-152M', REL=1.00E-0 &END
  &RADI NUC='EU-154', REL=1.00E-0 &END
  &RADI NUC='EU-155', REL=1.00E-0 &END
  &RADI NUC='EU-156', REL=1.00E-0 &END
  &RADI NUC='F-18', REL=1.00E-0 &END
  &RADI NUC='FE-55', REL=1.00E-0 &END
  &RADI NUC='FE-59', REL=1.00E-0 &END
  &RADI NUC='FR-221', REL=1.00E-0 &END
  &RADI NUC='FR-223', REL=1.00E-0 &END
```

```
 MODIFICATIONS OF NUCLIDE DATA
 1
  &MODI NUC='BA-137M',LAMRR=6.29E-5 &END
 AG DATA
  &AGDT FV=0.7,0.3,0.0,FB=0.442,0.558,0.0,FM=0.399,0.601,0.0 &END
 COMMENTS
 Ground-level release
 Unit Ci dose to Frenchman's cabin
 10-year average meteorology, 1994-2003
 *


1INEL IMPLEMENTATION OF THE CAP88 COMPUTER CODE SYSTEM

 THE DATE AND TIME ARE:  Wed Jan 26 13:10:58 MST 2005
 USER NAME:  Name Tty Chris Staley pts/1
 USER ID:    cst
 THE UNIX ABSOLUTE PATH FOR THIS RUN IS:  /home/cst/04neshunit/intec


 THE FILES USED BY THIS RUN ARE:

                        Owner-Id   Date   Time  File Name
                        --------   ----   ----  ---------
     CAP88 OUTPUT FILE:    cst      Jan 26 13:10  /home/cst/04neshunit/intec/cpp6.cap

           PREPAR FILE:    cst      Jan 26 13:10  /home/cst/04neshunit/intec/cpp6.dat
           DARTAB FILE:    cst      Nov 23 16:31 inddar.dat

             WIND FILE:    pdr      Nov 10 18:29 /home/pdr/wind/9403wind/gril9403.str
             FARM FILE:    pdr      Mar  8  1995 /home/pdr/cary_smith_cap88/farm/cowveg2.dat
       POPULATION FILE:    pdr      Mar  8  1995 /home/pdr/cary_smith_cap88/pop/nrf.90

      ALLRAD DATA BASE:    pdr      Feb  3  2004 /home/pdr/cary_smith_cap88/radrisk/allrad88.dat
     RADRISK DATA BASE:    pdr      Feb  3  2004 /home/pdr/cary_smith_cap88/radrisk/rad.new



 PREPARED BY: ______________________________________________________ DATE: _______________



 REVIEWED BY: ______________________________________________________ DATE: _______________
1
  ALLRAD FILE     ===> ALLRAD88 CONTAINS THE DCFs
  POP FILE        ===> CONTAINS THE POPULATION GRID (POP RUNS ONLY)
1
                 SYNOPSIS REPORT - CAP-88 (1.00)

 ID Code:                             Date/Time: Wed Jan 26 13:10:58 2005

 FACILITY: IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY
  ADDRESS: BECHTEL BWXT LLC GEOSCIENCES DEPARTMENT
     CITY: IDAHO FALLS
    State: ID     Zipcode: 83415-2107

 Source Category:  CPP - UNIT CI DOSE TO FRENCHMAN'S CABI  Source Term: 2004

 Comments:
 Ground-level release
 Unit Ci dose to Frenchman's cabin
```

INDIVIDUAL AT MAXIMUM RISK ASSESSEMENT
(RN-222 RISKS EXCLUDED)

Location to the individual: 18718 METERS SOUTH SOUTHWEST

	GONADS	BREAST	R MAR	LUNGS	THYROID	ENDOST	RMNDR
ORGAN DOSE (MREM/YR):	3.8E-02	3.6E-02	1.1E+00	2.9E-01	6.4E-02	1.1E+01	6.8E-01

ICRP Effective Dose Equivalent (mrem/yr): 7.19E-01
Lifetime Fatal Cancer Risk : 6.98E-06

Stack #1

SOURCE TERM (2004)

Nuclide	Class	Amad	Stack #1 Ci/yr	TOTAL
RU-103	Y	1.00	1.00E+00	1.00E+00
RU-105	Y	1.00	1.00E+00	1.00E+00
RU-106	Y	1.00	1.00E+00	1.00E+00
RH-106	Y	1.00	1.00E+00	1.00E+00
RU-97	Y	1.00	1.00E+00	1.00E+00
S-35	D	1.00	1.00E+00	1.00E+00
SB-124	W	1.00	1.00E+00	1.00E+00
SB-125	W	1.00	1.00E+00	1.00E+00
TE-125M	W	1.00	2.50E-01	2.50E-01
SB-126	W	1.00	1.00E+00	1.00E+00
SB-126M	W	1.00	1.00E+00	1.00E+00
SB-127	W	1.00	1.00E+00	1.00E+00
SC-46	Y	1.00	1.00E+00	1.00E+00
SM-147	W	1.00	1.00E+00	1.00E+00
SM-151	W	1.00	1.00E+00	1.00E+00
SM-153	W	1.00	1.00E+00	1.00E+00
SN-113	W	1.00	1.00E+00	1.00E+00
SN-123		0.00	1.00E+00	1.00E+00
SN-125	W	1.00	1.00E+00	1.00E+00
SN-126	W	1.00	1.00E+00	1.00E+00
SR-89	D	1.00	1.00E+00	1.00E+00
SR-90	D	1.00	1.00E+00	1.00E+00
Y-90	Y	1.00	1.00E+00	1.00E+00
SR-91	D	1.00	1.00E+00	1.00E+00
SR-92	D	1.00	1.00E+00	1.00E+00
TB-160	W	1.00	1.00E+00	1.00E+00
TC-101		0.00	1.00E+00	1.00E+00
TC-97	W	1.00	1.00E+00	1.00E+00
TC-99	W	1.00	1.00E+00	1.00E+00
TC-99M	W	1.00	1.00E+00	1.00E+00

```
                              SITE INFORMATION
                              ----------------

      Temperature:      6  C
         Rainfall:     21  cm/yr
    Mixing Height:    800 meters


                           EMISSION INFORMATION
                           --------------------

          Stack Number:    1
                       --------
  STACK HEIGHT (METERS) :    0.00
 STACK DIAMETER (METERS):    0.00
  PLUME RISE
      MOMENTUM (M/SEC) :0.00E+00

                           FOOD SUPPLY FRACTIONS
                           ---------------------

                      LOCAL     REGIONAL     IMPORTED
                      -----     --------     --------
         Vegetable:   0.700     0.300        0.000
              Meat:   0.442     0.558        0.000
              Milk:   0.399     0.601        0.000

 FOOD ARRAYS WERE NOT GENERATED OR SUPPLIED FOR THIS RUN .  DEFAULT VALUES USED.

               DISTANCES USED FOR MAXIMUM INDIVIDUAL ASSESSMENT
               ------------------------------------------------
  18718
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0INDEX	NAME	ISOL CLASS	LAMSUR 1/D	UPTAKE F1ING	AMAD MICRONS
1	RU-103	Y	5.48E-05	0.05	1.00
2	RU-105	Y	5.48E-05	0.05	1.00
3	RU-106	Y	5.48E-05	0.05	1.00
4	RH-106	Y	5.48E-05	0.05	1.00
5	RU-97	Y	5.48E-05	0.05	1.00
6	S-35	D	5.48E-05	0.80	1.00
7	SB-124	W	5.48E-05	0.10	1.00
8	SB-125	W	5.48E-05	0.10	1.00
9	TE-125M	W	5.48E-05	0.20	1.00
10	SB-126	W	5.48E-05	0.10	1.00
11	SB-126M	W	5.48E-05	0.10	1.00
12	SB-127	W	5.48E-05	0.10	1.00
13	SC-46	Y	5.48E-05	0.00	1.00
14	SM-147	W	5.48E-05	0.00	1.00
15	SM-151	W	5.48E-05	0.00	1.00
16	SM-153	W	5.48E-05	0.00	1.00
17	SN-113	W	5.48E-05	0.02	1.00
18	SN-123		5.48E-05	0.00	0.00
19	SN-125	W	5.48E-05	0.02	1.00
20	SN-126	W	5.48E-05	0.02	1.00
21	SR-89	D	5.48E-05	0.30	1.00
22	SR-90	D	5.48E-05	0.30	1.00
23	Y-90	Y	5.48E-05	0.00	1.00
24	SR-91	D	5.48E-05	0.30	1.00
25	SR-92	D	5.48E-05	0.30	1.00
26	TB-160	W	5.48E-05	0.00	1.00
27	TC-101		5.48E-05	0.00	0.00
28	TC-97	W	5.48E-05	0.80	1.00
29	TC-99	W	5.48E-05	0.80	1.00
30	TC-99M	W	5.48E-05	0.80	1.00

INDEX	NAME	SC 1/S	VD M/S	VG M/S	ANLAM 1/D
1	RU-103	2.08E-06	1.80E-03	3.55E-05	1.76E-02
2	RU-105	2.08E-06	1.80E-03	3.55E-05	3.75E+00
3	RU-106	2.08E-06	1.80E-03	3.55E-05	1.88E-03
4	RH-106	2.08E-06	1.80E-03	3.55E-05	1.88E-03
5	RU-97	2.08E-06	1.80E-03	3.55E-05	2.48E-01
6	S-35	2.08E-06	1.80E-03	3.55E-05	7.93E-03
7	SB-124	2.08E-06	1.80E-03	3.55E-05	1.15E-02
8	SB-125	2.08E-06	1.80E-03	3.55E-05	6.85E-04
9	TE-125M	2.08E-06	1.80E-03	3.55E-05	6.85E-04
10	SB-126	2.08E-06	1.80E-03	3.55E-05	5.59E-02
11	SB-126M	2.08E-06	1.80E-03	3.55E-05	5.25E+01
12	SB-127	2.08E-06	1.80E-03	3.55E-05	1.80E-01
13	SC-46	2.08E-06	1.80E-03	3.55E-05	8.27E-03
14	SM-147	2.08E-06	1.80E-03	3.55E-05	1.78E-14
15	SM-151	2.08E-06	1.80E-03	3.55E-05	2.11E-05
16	SM-153	2.08E-06	1.80E-03	3.55E-05	3.56E-01
17	SN-113	2.08E-06	1.80E-03	3.55E-05	6.02E-03
18	SN-123	2.08E-06	1.80E-03	0.00E+00	5.36E-03
19	SN-125	2.08E-06	1.80E-03	3.55E-05	7.20E-02
20	SN-126	2.08E-06	1.80E-03	3.55E-05	1.90E-08
21	SR-89	2.08E-06	1.80E-03	3.55E-05	1.37E-02
22	SR-90	2.08E-06	1.80E-03	3.55E-05	6.64E-05
23	Y-90	2.08E-06	1.80E-03	3.55E-05	6.64E-05
24	SR-91	2.08E-06	1.80E-03	3.55E-05	1.75E+00
25	SR-92	2.08E-06	1.80E-03	3.55E-05	6.14E+00
26	TB-160	2.08E-06	1.80E-03	3.55E-05	9.59E-03
27	TC-101	2.08E-06	1.80E-03	0.00E+00	7.03E+01
28	TC-97	2.08E-06	1.80E-03	3.55E-05	7.30E-10
29	TC-99	2.08E-06	1.80E-03	3.55E-05	8.91E-09
30	TC-99M	2.08E-06	1.80E-03	3.55E-05	2.76E+00

0 ***NOTE: VG SET TO ZERO FOR AIRDOS UNLESS GREATER THAN 1.000E-02
0 ***NOTE: ANLAM SET TO ZERO FOR AIRDOS UNLESS GREATER THAN 1.000E-02

1 INEL MAXIMUM INDIVIDUAL DARTAB OUTPUT TABLES
INDIVIDUAL DOSE EQ. RATE(MREM/YEAR)

0***FOR ORGAN :EFFEC

NUCLIDES	RU-103	RU-105	RU-106	RH-106	RU-97	S-35	SB-124	SB-125	TE-125M	SB-126
	SB-126M	SB-127	SC-46	SM-147	SM-151	SM-153	SN-113	SN-123	SN-125	SN-126
	SR-89	**SR-90**	**Y-90**	SR-91	SR-92	TB-160	TC-101	TC-97	TC-99	TC-99M
	TOTAL									
PATHWAYS										
INGESTION	1.42E-04	7.30E-15	2.10E-03	6.61E-07	3.29E-07	1.83E-04	5.29E-04	2.22E-04	1.46E-04	1.86E-04
	1.73E-58	1.08E-05	6.21E-04	1.98E-02	4.11E-05	2.40E-07	1.06E-03	0.00E+00	3.04E-04	1.18E-02
	5.03E-04	3.67E-02	8.14E-04	5.89E-09	1.22E-13	4.41E-04	0.00E+00	9.38E-04	8.05E-03	7.34E-11
	8.46E-02									
% OF INTERNAL	6.58E+01	2.08E-07	3.53E+01	9.67E+01	7.86E+00	9.87E+01	7.19E+01	6.95E+01	9.07E+01	6.53E+01
	1.16E-48	1.75E+01	7.20E+01	3.18E+00	1.45E+01	1.38E+00	9.22E+01	0.00E+00	7.01E+01	9.39E+01
	9.06E+01	9.54E+01	9.15E+01	8.07E-02	4.20E-06	6.83E+01	0.00E+00	9.91E+01	9.92E+01	3.32E-02
	1.21E+01									
% OF ALL PATHWAYS	2.98E+01	9.72E-08	3.53E+01	6.67E-02	2.28E+00	9.87E+01	2.47E+01	3.86E+00	6.50E+01	2.46E+01
	5.61E-50	1.10E+01	2.07E+01	3.18E+00	1.44E+01	1.24E+00	9.04E+01	0.00E+00	6.44E+01	5.56E+01
	9.05E+01	9.54E+01	9.15E+01	4.48E-02	1.61E-06	2.67E+01	0.00E+00	5.04E+01	9.92E+01	6.98E-03
	1.18E+01									
INHALATION	7.36E-05	3.52E-06	3.84E-03	2.25E-08	3.86E-06	2.39E-06	2.07E-04	9.75E-05	1.50E-05	9.87E-05
	1.50E-08	5.09E-05	2.41E-04	6.05E-01	2.43E-04	1.72E-05	9.03E-05	0.00E+00	1.30E-04	7.64E-04
	5.25E-05	1.79E-03	7.57E-05	7.29E-06	2.90E-06	2.04E-04	0.00E+00	8.06E-06	6.75E-05	2.21E-07
	6.13E-01									
% OF INTERNAL	3.42E+01	1.00E+02	6.47E+01	3.29E+00	9.21E+01	1.29E+00	2.81E+01	3.05E+01	9.28E+00	3.47E+01
	1.00E+02	8.25E+01	2.80E+01	9.68E+01	8.55E+01	9.86E+01	7.82E+00	0.00E+00	2.99E+01	6.10E+00
	9.44E+00	4.65E+00	8.51E+00	9.99E+01	1.00E+02	3.17E+01	0.00E+00	8.52E-01	8.32E-01	1.00E+02
	8.79E+01									
% OF ALL PATHWAYS	1.55E+01	4.68E+01	6.47E+01	2.27E-03	2.67E+01	1.29E+00	9.66E+00	1.69E+00	6.65E+00	1.30E+01
	4.85E+00	5.16E+01	8.03E+00	9.68E+01	8.54E+01	8.88E+01	7.67E+00	0.00E+00	2.75E+01	3.61E+00
	9.44E+00	4.65E+00	8.51E+00	5.54E+01	3.84E+01	1.24E+01	0.00E+00	4.33E-01	8.32E-01	2.10E+01
	8.52E+01									
AIR IMMERSION	2.40E-06	2.68E-06	0.00E+00	1.05E-06	1.11E-06	0.00E+00	9.91E-06	2.12E-06	1.18E-08	1.41E-05
	2.84E-07	3.30E-06	1.05E-05	0.00E+00	4.51E-12	2.39E-07	4.12E-08	3.60E-08	1.60E-06	2.35E-07
	7.15E-10	0.00E+00	0.00E+00	2.94E-06	3.69E-06	5.58E-06	2.67E-08	4.66E-09	2.56E-12	4.77E-07
	6.23E-05									
% OF EXTERNAL	9.25E-01	6.70E+01	0.00E+00	1.06E-01	1.08E+01	0.00E+00	7.06E-01	3.89E-02	1.86E-02	2.98E+00
	9.65E+01	8.91E+00	4.90E-01	0.00E+00	7.74E-04	1.23E+01	1.82E-01	3.25E-01	4.18E+00	2.72E-03
	7.88E-01	0.00E+00	0.00E+00	5.01E+01	7.93E+01	5.54E-01	9.72E+01	5.10E-04	2.93E-03	5.74E+01
	2.90E-01									
% OF ALL PATHWAYS	5.06E-01	3.56E+01	0.00E+00	1.06E-01	7.70E+00	0.00E+00	4.63E-01	3.68E-02	5.26E-03	1.86E+00
	9.18E+01	3.34E+00	3.49E-01	0.00E+00	1.58E-06	1.23E+00	3.50E-03	3.25E-01	3.39E-01	1.11E-03
	1.29E-04	0.00E+00	0.00E+00	2.23E+01	4.88E+01	3.38E-01	9.72E+01	2.51E-04	3.15E-08	4.53E+01

	8.66E-03									
GROUND SURFACE	2.57E-04	1.32E-06	0.00E+00	9.89E-04	9.15E-06	0.00E+00	1.39E-03	5.44E-03	6.37E-05	4.58E-04
	1.03E-08	3.37E-05	2.13E-03	0.00E+00	5.82E-07	1.70E-06	2.26E-05	1.10E-05	3.67E-05	8.63E-03
	9.00E-08	0.00E+00	0.00E+00	2.92E-06	9.63E-07	1.00E-03	7.66E-10	9.15E-04	8.73E-08	3.54E-07
	2.14E-02									
% OF EXTERNAL	9.91E+01	3.30E+01	0.00E+00	9.99E+01	8.92E+01	0.00E+00	9.93E+01	1.00E+02	1.00E+02	9.70E+01
	3.49E+00	9.11E+01	9.95E+01	0.00E+00	1.00E+02	8.77E+01	9.98E+01	9.97E+01	9.58E+01	1.00E+02
	9.92E+01	0.00E+00	0.00E+00	4.99E+01	2.07E+01	9.94E+01	2.79E+00	1.00E+02	1.00E+02	4.26E+01
	9.97E+01									
% OF ALL PATHWAYS	5.42E+01	1.76E+01	0.00E+00	9.98E+01	6.33E+01	0.00E+00	6.51E+01	9.44E+01	2.83E+01	6.05E+01
	3.32E+00	3.42E+01	7.09E+01	0.00E+00	2.04E-01	8.77E+00	1.92E+00	9.97E+01	7.77E+00	4.08E+01
	1.62E-02	0.00E+00	0.00E+00	2.22E+01	1.28E+01	6.06E+01	2.79E+00	4.92E+01	1.08E-03	3.37E+01
	2.98E+00									
INTERNAL	2.15E-04	3.52E-06	5.95E-03	6.83E-07	4.19E-06	1.85E-04	7.36E-04	3.20E-04	1.61E-04	2.85E-04
	1.50E-08	6.18E-05	8.61E-04	6.24E-01	2.84E-04	1.74E-05	1.15E-03	0.00E+00	4.34E-04	1.25E-02
	5.56E-04	3.85E-02	8.90E-04	7.30E-06	2.90E-06	6.45E-04	0.00E+00	9.46E-04	8.12E-03	2.21E-07
	6.97E-01									
% OF ALL PATHWAYS	4.53E+01	4.68E+01	1.00E+02	6.89E-02	2.90E+01	1.00E+02	3.44E+01	5.55E+00	7.17E+01	3.76E+01
	4.85E+00	6.25E+01	2.87E+01	1.00E+02	9.98E+01	9.00E+01	9.81E+01	0.00E+00	9.19E+01	5.92E+01
	1.00E+02	1.00E+02	1.00E+02	5.55E+01	3.84E+01	3.90E+01	0.00E+00	5.08E+01	1.00E+02	2.10E+01
	9.70E+01									
EXTERNAL	2.60E-04	4.00E-06	0.00E+00	9.90E-04	1.03E-05	0.00E+00	1.40E-03	5.44E-03	6.37E-05	4.72E-04
	2.94E-07	3.70E-05	2.14E-03	0.00E+00	5.82E-07	1.94E-06	2.26E-05	1.11E-05	3.83E-05	8.63E-03
	9.07E-08	0.00E+00	0.00E+00	5.86E-06	4.65E-06	1.01E-03	2.75E-08	9.15E-04	8.74E-08	8.31E-07
	2.15E-02									
% OF ALL PATHWAYS	5.47E+01	5.32E+01	0.00E+00	9.99E+01	7.10E+01	0.00E+00	6.56E+01	9.44E+01	2.83E+01	6.24E+01
	9.51E+01	3.75E+01	7.13E+01	0.00E+00	2.04E-01	1.00E+01	1.92E+00	1.00E+02	8.11E+00	4.08E+01
	1.63E-02	0.00E+00	0.00E+00	4.45E+01	6.16E+01	6.10E+01	1.00E+02	4.92E+01	1.08E-03	7.90E+01
	2.99E+00									
TOTAL OVER ALL PATHWAYS	4.75E-04	7.51E-06	5.95E-03	9.91E-04	1.44E-05	1.85E-04	2.14E-03	5.76E-03	2.25E-04	7.57E-04
	3.09E-07	9.88E-05	3.00E-03	6.24E-01	2.85E-04	1.94E-05	1.18E-03	1.11E-05	4.72E-04	2.12E-02
	5.56E-04	**3.85E-02**	**8.90E-04**	1.32E-05	7.55E-06	1.65E-03	2.75E-08	1.86E-03	8.12E-03	1.05E-06
	7.19E-01									

```
1PREPAR NAMELIST INPUT FILE

  C-SHELL SCRIPT  ===> HP.CSH RUNS THE CAP88 SYSTEM
  ALLRAD FILE     ===> ALLRAD88 CONTAINS THE DCFs
  POP FILE        ===> CONTAINS THE POPULATION GRID (POP RUNS ONLY)
  STARFILE        ===> INEEL MESONET DATA
  RADRISK FILE    ===> EPA
 *
 IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY
 BECHTEL BWXT LLC GEOSCIENCES DEPARTMENT
 IDAHO FALLS
 ID
 83415-2107
 CPP - UNIT CI DOSE TO FRENCHMAN'S CABIN
 2004
 OPTION
  &OPTI OPTION=0,1,0,1,0,0,0,1,0,LIST=1,LIPO=0,
   NUTB=0,NSTB=0,NNTB=0,NTTB=1,NRTB=0,TSUBB=100. &END
 GRID
  &GRID NOL=8,NOU=8,NRL=1,NRU=1,IDIST=18718 &END
 METEOROLOGICAL DATA
  &METE LID=800.0,RR=20.8,TA=279.,TG=7.28E-2,1.09E-1,1.455E-1,
   Z=10.,Z0=0.01,J0=0.001,DF=0.0 &END
 PHYSICAL STACK DATA
 1
  &PHYS PH=0.0, VEL=0.0, DIA=0.0 &END
 WIND FREQUENCY DATA
 STAR
 DEFAULT
 RADIONUCLIDE DATA
 30
  &RADI NUC='RU-103', REL=1.00E-0 &END
  &RADI NUC='RU-105', REL=1.00E-0 &END
  &RADI NUC='RU-106', REL=1.00E-0 &END
  &RADI NUC='RH-106', REL=1.00E-0,IAN=-1 &END
  &RADI NUC='RU-97', REL=1.00E-0 &END
  &RADI NUC='S-35', REL=1.00E-0 &END
  &RADI NUC='SB-124', REL=1.00E-0 &END
  &RADI NUC='SB-125', REL=1.00E-0 &END
  &RADI NUC='TE-125M', REL=2.50E-1,IAN=-1 &END
  &RADI NUC='SB-126', REL=1.00E-0 &END
  &RADI NUC='SB-126M', REL=1.00E-0 &END
  &RADI NUC='SB-127', REL=1.00E-0 &END
  &RADI NUC='SC-46', REL=1.00E-0 &END
  &RADI NUC='SM-147', REL=1.00E-0 &END
  &RADI NUC='SM-151', REL=1.00E-0 &END
  &RADI NUC='SM-153', REL=1.00E-0 &END
  &RADI NUC='SN-113', REL=1.00E-0 &END
  &RADI NUC='SN-123', REL=1.00E-0 &END
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  &RADI NUC='SN-126', REL=1.00E-0 &END
  &RADI NUC='SR-89', REL=1.00E-0 &END
  &RADI NUC='SR-90', REL=1.00E-0 &END
  &RADI NUC='Y-90', REL=1.00E-0,IAN=-1 &END
  &RADI NUC='SR-91', REL=1.00E-0 &END
  &RADI NUC='SR-92', REL=1.00E-0 &END
  &RADI NUC='TB-160', REL=1.00E-0 &END
  &RADI NUC='TC-101', REL=1.00E-0 &END
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  &RADI NUC='TC-99', REL=1.00E-0 &END
  &RADI NUC='TC-99M', REL=1.00E-0 &END
 MODIFICATIONS OF NUCLIDE DATA
 3
  &MODI NUC='RH-106',LAMRR=1.88E-3 &END
  &MODI NUC='TE-125M',LAMRR=6.85E-4 &END
  &MODI NUC='Y-90',LAMRR=6.64E-5 &END
```

```
AG DATA
 &AGDT FV=0.7,0.3,0.0,FB=0.442,0.558,0.0,FM=0.399,0.601,0.0 &END
COMMENTS
Ground-level release
Unit Ci dose to Frenchman's cabin
10-year average meteorology, 1994-2003
*
```

INL Modeling Certification Statement

I certify that air dispersion and/or dose modeling conducted for the project:

TSF-26 PM-2A CERCLA TANK TREATMENT PROJECT

was performed in accordance with the *INEEL Air Modeling Protocol*, INEEL/EXT-04-02511.

Signed,

4/18/05

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Appendix B. APAD Technical Reviewer Quality Checklist

Instructions: This checklist is provided to assist in the Quality Review of the APAD form. For each question enter the review date in the applicable box.

Quality Review Questions	Yes	No	N/A	Date
1. Have sections C through J been completed?	X			4/27/05
2. Does Section D provide an adequate description of the project, and is it substantiated by the information in the draft or final EC, Appendix A, and/or the project information file?	X			4/27/05
3. Have the applicable boxes in Section E been marked appropriately based on the scope of the project presented in the draft or final EC, Appendix A, and/or the project information file?	X			4/27/05
3a. Have applicable requirements been listed for impacts checked in Section E?	X			4/27/05
4. Has a detailed task/responsibility been prescribed for Facility/Project personnel in Section G for each requirement presented in Section F?	X			4/27/05
4a. Does each task provide sufficient detail to direct facility/project personnel in maintaining, demonstrating, and documenting compliance?	X			4/27/05
5. Have all the applicable boxes for reports been checked in Section H based on the presence/absence of potential air pollutant emissions or 40 CFR 68 regulated chemicals identified in Section D, Appendix A, the draft or final EC, and/or the project information file?	X			4/27/05
5a. Has the Annual Toxics Report been accurately marked if toxic air pollutants are present? The Annual Toxics Report for this project will not be filed as it viewed as an administrative requirement under CERCLA.			X	4/27/05
5b. Has the NESHAPs Annual Report been accurately marked if radiological emissions are present?	X			4/27/05
5c. Has the AEI been accurately marked if this is a new source, an existing source, or an inactivation of an existing source?			X	4/27/05
6. Is the justification in Section I accurate and consistent with EA Policy, and substantiated by the information in the APAD Appendix A?	X			4/27/05
6a. If the APAD indicates this is a pre-existing source where no increase in emissions are expected or no construction or modification impacting existing source parameters are expected, has it been adequately documented?	X			4/27/05
7. Has Section J identified applicable Toxic Air Pollutants likely to be emitted based on the scope of work described by Section D?	X			4/27/05
8. Has sufficient information been provided by the facility/project and included in Appendix A and/or the project information file to make an accurate permitting determination?	X			4/27/05
8a. Are the emission calculations accurate, reasonable, and defendable?	X			4/27/05
8b. Have all equations been clearly shown including all variables and sources of variables, and have adequate assumptions been provided?	X			4/27/05
8c. Have appropriate modeling results been included or referenced?	X			4/27/05
8d. If modeled as a ground release, has emission source applicability for ground release modeling been verified?	X			4/27/05
8e. If applicable, has a quality statement been signed and submitted by the modeler confirming that modeling was performed in accordance with the INEEL Air Modeling Protocol INEEL/INT-98-00236?			X	4/27/05
9. If questions 1 through 8 have been marked "Yes" or "N/A" has a consistency check been completed by the EA Policy and Permitting Manager or Designee?			X	4/27/05

Reviewer Comments:

Instructions: Insert reviewer comments if necessary.

Independent Technical Review Performed By:

D. L. Eaton	[signature]	4/27/05
Print/Type Name	Signature	Date

AIR PERMITTING APPLICABILITY DETERMINATION

Appendix C. Project/Facility Manager Requirements Quality Checklists

Instructions: These checklists are provided to assist in the quality review of the APAD requirements. For each numbered question enter the review date in the applicable box. The Project Manager and Facility Manager are required to complete their respective checklists prior to issuance of a complete APAD.

Project Manager

Requirements and Quality Review Questions	Yes	No	N/A	Date
1. Is the information in this APAD accurate and complete to the best of your knowledge?	X			3/14/05
2. Does the information in Section D and the APAD Information File provide an accurate description of the project and its anticipated scope?	X			3/14/05
3. Can the project satisfy all the requirements specified in Section G, and provide all the specified information?	X			3/14/05
4. Do you acknowledge the requirement to provide notice of project status within the time period specified in the APAD in order to prevent cancellation of the APAD authorization?	X			3/14/05
5. Do you acknowledge the need to request an APAD revision from EA should the project scope, potential emissions, and/or actual emissions change from what was previously presented in Section D, Appendix A, and/or the APAD Information File?	X			3/14/05

Who is responsible for providing notice to EA for the annual project status update and the one-time project construction, operation, completion, and cancellation notices?

Project Manager or Designee

Who is responsible for providing written notice to EA of any changes to the scope of the project as currently documented in Section D and the APAD information file?

Project Manager or Designee

In which on-site record storage facility will a copy of this APAD be maintained?

EDMS or Project File

Who is the current records coordinator for the on-site record storage facility?

Marcia Mais

Project Manager:
Signature indicates that the reviewer has completed the checklist, verifies that the information is true, accurate, and complete, and accepts responsibility for ensuring that the final signed copy is sent to the designated records storage facility.

A. K. Yonk — Print/Type Name
[signature] — Signature
04/27/05 — Date

Facility Manager

Requirements and Quality Review Questions	Yes	No	N/A	Date
1. Do you recognize and acknowledge that the tasks presented in Section G are the responsibility of the performing organization/facility and are required in order to demonstrate compliance?	X			4/27/05
2. Can the facility satisfy all the requirements specified in Section G, and provide all the specified information? Requirements can be satisfied by several means (e.g. equipment operating logs, procedures, assessments, engineering design files, monthly or annual reports).	X			4/27/05
3. Do you concur with the records storage location and coordinator designated above?	X			4/27/05

Facility Manager:
Signature indicates that the reviewer has completed the checklist and verifies that the information is true, accurate, and complete.

S. M. Edgett — Print/Type Name
[signature] — Signature
4/27/05 — Date